A projected image displaying apparatus and a method of correcting color unevenness therein

Patent number: CN1092233
Publication date: 1994-09-14
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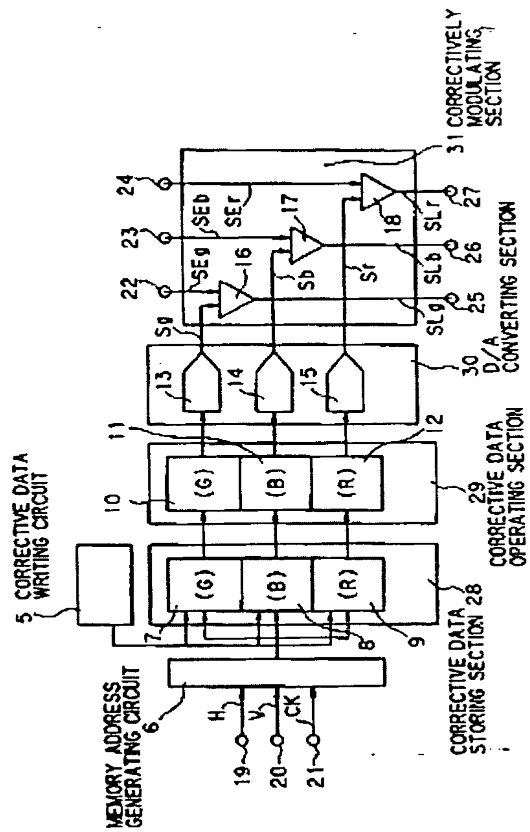
Classification:
- international: H04N9/43; H04N9/68; H04N5/74; G02F1/13
- european:
Application number: CN19930114121 19931030
Priority number(s): JP19920292621 19921030

Also published as:
- EP0595649 (A1)
- US5452019 (A1)
- JP6138849 (A)
- EP0595649 (B1)

Abstract not available for CN1092233
Abstract of correspondent: **EP0595649**

A chromaticity meter measures chromaticity of light output for each of picture elements selected. Calculated from the measurement is corrective data on each of RGB colors, which in turn used to calculate corrective data on each of RGB at unselected picture elements. In this method, original video signals for each of RGB colors will be correctively modulated based on the thus obtained corrective data. A projected image displaying apparatus is constructed such that adjustment of chromaticity as to white as well as to black from the measurement by the chromaticity meter of chromaticity throughout the entire image, is carried out uniformly and reliably by automatic control using a micro-computer so as to determine optimal condition for correctively modulating the original video signal. This apparatus further includes means for storing the thus obtained optimal condition in a non-volatile memory.

FIG.8



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A projected image displaying apparatus and a method of correcting color unevenness therein

Description of correspondent: EP0595649

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to a projected image displaying apparatus using a plurality of display devices, and further the present invention relates to a method of correcting color unevenness in a projected image displaying apparatus wherein color unevenness over the entire display image can be corrected, and to a display apparatus capable of automatically effecting chromaticity adjustment that is to be performed at a production stage, etc.

(2) Description of the Prior Art

In projected image displaying apparatuses using a plurality of display devices, it is required to strictly control characteristics of display elements in order to establish uniformity of chromaticity throughout the entire display image, but the chromaticity throughout the projected image varies position to position depending upon color rendering properties of a light source used, a color separation/composition system used for the light source and transmittance distribution of the display elements and other factors. Therefore it very difficult in a technological view point to establish such a strict control in a projected image display apparatus.

There is a method called "white-balance adjusting method" in which a video signal is composed of red, blue and green component video signals (which will hereinafter be referred to as R-signal, G-signal and B-signal, respectively), and amplitude of each component is variable so as to effect gain-control, whereby chromaticity can be adjusted roughly throughout the entire image.

Japanese Patent Application Laid-Open Sho 63 No.37,785 discloses a method of correcting unevenness of luminance and chromaticity arising in a case where an image screen is formed by arranging a plurality of liquid crystal display panels. This method comprises the steps of: measuring each liquid crystal display panel in its real mounted state on light intensity; generating data on uniformity ratio of illuminance for each liquid crystal display panel on the basis of the obtained light intensity so as to store the generated data in the memory; and executing a calculative operation based on the stored data and projected image data on each liquid crystal display panel so as to display a uniform projected image.

Now, a conventional chromaticity adjusting method will be explained with reference to Fig.1, which is a block diagram showing a circuit for generating video signals to be provided for a typical liquid crystal display device. In this figure, gamma -correcting circuits 55r, 55g and 55b are constructed identically, and analog converting circuits 56r, 56g and 56b are also constructed all identically like an analog converting circuit 56 shown in Fig.2.

A video signal 51 having an analog value is inputted to a projected image processing section 54 in which the inputted data is separated into R-signal, G-signal and B-signal. The thus separated signals pass through A/D converting circuits a54r, a54g and a54b in the projected image processing section 54 to be formed into quantized digital video signals S1R, S1G and S1B, which are in turn sent out to gamma -correcting circuits 55r, 55g and 55b.

The gamma -correcting circuits 55r, 55g and 55b are to perform gamma -correction for making compensation for voltage-transmittance characteristic of liquid crystal, and subject the inputted respective digital video signals S1R, S1G and S1B to gamma -correction to output digital video signals S gamma R, S gamma G and S gamma B to analog converting circuits 56r, 56g and 56b, respectively.

The analog converting circuits 56r, 56g and 56b convert the inputted digital video signals S gamma R, S gamma G and S gamma B into analog values, respectively. The thus formed analog values are sent out as video signal SR, SG and SB to a liquid crystal display device/optical converting section 57.

The liquid crystal display device/optical converting section 57, based on the inputted video signal SR, SG and SB, reproduces an image and emits light output RAY.

A chromaticity meter receives the light output RAY emitted as an image from the liquid crystal display device/optical converting section 57, and measures the chromaticity thereof to indicate the measurement. Here, for convenience of description, liquid crystal display device used is assumed to be of a normally white type, more explicitly, the liquid crystal display device is assumed to lower its transmittance as the voltage applied increases. Further assumption is that the device is driven by an alternating voltage which has a center voltage of ground level and inverts its polarity for every horizontal line.

56g and 56b. Fig.2 is a circuit diagram of the analog converting circuit 56. There are three analog converting circuits 56 on the diagram shown in Fig.1, namely, analog converting circuit 56r for processing the R-signal, analog converting circuit 56g for processing the G-signal and analog converting circuit 56b for processing the B-signal. Here, Figs.3A through 3F are diagrams showing waveforms of video signals for different points in 56.

As shown in Fig.3B, a control signal S6 has a waveform taking a peak value, or voltage H for 'High' level and taking another peak value, or voltage L for 'Low' level, and alternating between 'High' level and 'Low' level, periodically. This signal is inputted into a logical circuit 62, switches SW1, SW2 and SW3, and serves as a synchronizing signal.

When the control signal S6 is at 'High' level in switches SW1, SW2 and SW3, all terminals 'c' are simultaneously connected with respective terminals 'b' and are simultaneously disconnected with respective terminals 'a'. On the other hand, when the control signal S6 is at 'Low' level, all terminals 'c' are simultaneously connected with respective terminals 'a' and are simultaneously disconnected with respective terminals 'b'.

In the switch SW1, the terminal 'a' is applied with a full-scale voltage VFS that is adjusted by a variable resistance R1 whereas the terminal 'b' is grounded. As previously described, the terminals 'a' and 'b' are alternately connected with the terminal 'c' following the control signal S6 inputted to a terminal 'd'. With the alternating connection, the terminal 'c' generates a pulse having a peak value equal to the full-scale voltage V.FS and launches the pulse as a signal S11 to a negative (-)terminal of an amplifier AMP1. The signal S11 inputted to the (-)terminal of the amplifier AMP1 is therein multiplied by (-1) to output a waveform shown in Fig.3D.

In the switch SW2, the terminal 'a' is applied with an offset voltage VOF that is adjusted by a variable resistance R2 whereas the terminal 'b' is grounded. As previously described, the terminals 'a' and 'b' are alternately connected with the terminal 'c' following the control signal S6 inputted to a terminal 'd'. With the alternating connection, the terminal 'c' generates a pulse having a peak value equal to the offset voltage VOF and launches the pulse as a signal S16 to a positive (+)terminal of an amplifier AMP3. In the switch SW3, the terminal 'b' is applied with an offset voltage VOF that is adjusted by a variable resistance R2 whereas the terminal 'a' is grounded. As previously described, the terminals 'a' and 'b' are alternately connected with the terminal 'c' following the control signal S6 inputted to a terminal 'd'.With the alternating connection, the terminal 'c' generates a pulse having a peak value equal to the offset voltage VOF and launches the pulse as a signal S17 to a negative (-)terminal of the amplifier AMP3. Accordingly, these signals S16 and S17 synchronize with each other, but are logically inverted one another, or more specifically, when the signal S16 stays at 'High' level, the signal S17 is at 'Low' level.

The AMP3 subtracts the signal S17 inputted into the (-)terminal from the signal S16 inputted into the (+)terminal, and outputs the resultant signal S13 to a (-)terminal of an amplifier AMP2.

A digital video signal S8 corresponds to any one of the digital video signals S gamma R, S gamma G and S gamma B that have been quantized by and outputted from gamma -correcting circuit 55 r, 55g and 55b. By the way, the gamma -correcting circuit 55 r, 55g and 55b execute conversion of an inputted signal to form an output in accordance with a characteristic curve shown in Fig.4C, therefore, the digital video signal S8 is supplied to a logical circuit 62 as having a waveform taking a certain constant voltage VP shown in Fig.3A as a peak value.

The logical circuit 62 also receives a signal S6 alternately reversing at intervals of one horizontal period as having a waveform shown in Fig.3B, and effects a logical operation between the signal S6 and the digital video signal S8, whereby the digital video signal S8 is converted into digital video signal data series D0, D1, D2, (where the digital video signal S8 is digitized to indicate waveform constituents as it is and as inverted alternately every one horizontal period) as shown in Fig.3AA to be outputted to a D/A converter 59.

The D/A converter 59 receives at its referential voltage input terminal VREF an input of full-scale voltage VFS that has been adjusted by means of the variable resistance R1, and based on the input, converts the inputted video signal data series D0, D1, D2, ... into a corresponding analog signal, so as to form a video signal S9 having a waveform with the full-scale voltage VFS as a peak value as shown in Fig.3C. The thus generated signal S9 is outputted from an output terminal VOUT to a (+)terminal of the amplifier AMP1.

The amplifier AMP1 subtracts the signal S11 from the signal S9, and the resultant is outputted as a signal S12 to a (+)terminal of the amplifier AMP2. The signal S9 has a waveform shown in Fig.3C and the signal S11 multiplied by (-1) takes a waveform shown in Fig.3D. Accordingly, the signal S12 will have a waveform shown in Fig.3CC formed by the sum of the waveform shown in Fig.3C and the waveform shown in Fig.3D.

The amplifier AMP2 subtracts the signal S13 from the signal S12, and the resultant is outputted as a video signal S14 to the liquid crystal display device/optical converting section 57. This video signal S14 corresponds to any one of the video signals SR, SG and SB. The signal S12 has a waveform shown in Fig.3CC, and the signal S13 multiplied by (-1) takes a waveform shown in Fig.3E. Therefore, the signal S14 will have a waveform shown in Fig.3F formed by the sum of the waveform shown in Fig.3E and the waveform shown in Fig.3E.

As mentioned above, it is difficult for the conventional white-balance adjustment to inhibit the color unevenness in the image occurring due to the dispersion of individual device elements on the display image. On the other hand, the object of Japanese Patent Application Laid-Open Sho 63 No.37,785 cited above is to make correction between liquid crystal display panels arranged, therefore no irregularity or unevenness within the image cannot be corrected.

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crystal display devices for red, green and blue (which will hereinafter be referred to as R, G and B, respectively, and the three color, red, green and blue will be referred to as RGB.) having three respective circuits one for each. Therefore, these circuits are to involve dispersion in their circuit constants, and the three liquid crystal display devices must also have dispersion in voltage-transmittance characteristics. Such dispersion causes disadvantageous effects such as coloring an area that should be displayed in achromatic color like black and white. This disadvantage necessitates individual adjustment of the offset voltage VOF and the full-scale voltage VFS for each circuit.

In the prior art, this adjustment required the following procedures. Initially, data-input is made of a predetermined projected image such as, for example, a blank pattern for making pure white display on an entire image screen. Then, while the projected output generated by the optical conversion from the read data image should be measured using a chromaticity meter 58, the amplitude of the signals provided for the liquid crystal devices and the bias, more clearly, the full-scale voltage VFS and the offset voltage VOF for each device should be controlled by varying the variable resistance R1 for governing the full-scale voltage VFS and the resistance of the variable resistor R2 for governing the offset voltage VOF for each color block, so as to adjust the color-balance such as black and white.

However, this procedure requires an extremely fine adjustment and to make matters worse, it is very difficult to distinguish what resistors of which color block should be adjusted in what degree from the observed deviation of chromaticity. Therefore this method required even a skilled operator to take a very long time for the adjustment, posing a difficulty in production.

SUMMARY OF THE INVENTION

The present invention is to eliminate the above problems and it is therefore an object of the present invention to provide a projected image displaying apparatus wherein irregularity and unevenness on an image screen is eliminated by making correction in accordance with the chromaticity distribution on the image screen and provide a correcting method for the apparatus.

Another object of the present invention is to provide a displaying apparatus capable of automatically conducting chromaticity adjustment and a system therefor.

In order to achieve the above objects, the present invention is configurated as follows.

First of all, a projected image displaying apparatus of the present invention for forming images by projecting on a screen three kinds of lights corresponding to the primary color components of video signals, comprises:
chromaticity measuring means for measuring chromaticity at arbitrary coordinate points on the screen;
first operating means for calculating first corrective data on each of the primary color components uniquely from the chromaticity at the coordinate points measured by the chromaticity measuring means;
memory means for storing the first corrective data in association with the coordinates of the points at which chromaticity has been measured;;
second operating means reading out the first corrective data in association with a plurality of coordinate points from the memory means and calculating, based on the read-out first corrective data, second corrective data used for correctively modulating video signals to be applied to display elements emitting three primary color components in order to form picture elements at which no measurement of chromaticity was made; and
correctively modulating means, preparing video correcting signals for three primary color components based on the first and second corrective data calculated by the first and second operating means and modulating original video signals with the prepared video correcting signals.

In accordance with the present invention, a method for correcting color unevenness in a projected image displaying apparatus for forming images by projecting on a screen three kinds of lights corresponding to the primary color components of video signals, includes the steps of:
measuring chromaticity at arbitrary coordinate points on the screen (first step);
calculating first corrective data on each of the primary color components uniquely from the chromaticity at the coordinate points measured in the first step (second step);
storing the first corrective data into memory means in association with the coordinates of the points at which chromaticity has been measured (third step);;
reading out the first corrective data in association with a plurality of coordinate points from the memory means and calculating, based on the read-out first corrective data, second corrective data used for correctively modulating video signals to be applied to display elements emitting three primary color components in order to form picture elements at which no measurement of chromaticity was made (fourth step); and
preparing video correcting signals for three primary color components based on the first and second corrective data calculated in the second and fourth steps and modulating original video signals by the prepared video correcting signals (fifth step).

In accordance with another aspect of the present invention, a projected image displaying apparatus further includes:
voltage varying means capable of separately changing the amplitude voltages and bias voltages of video signals outputted to the display elements;
controlling means outputting control information for controlling the voltage varying means; and
memory means storing the control information outputted from the controlling means.

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Further aspect of the present invention lies in that a projected image displaying apparatus, includes:
a projected image displaying unit comprising:
voltage varying means capable of separately changing the amplitude voltages and bias voltages of video signals outputted to display elements;
first controlling means outputting first control information for controlling the voltage varying means; and
memory means storing the first control information outputted from the first controlling means, and
a chromaticity adjusting system comprising:
chromaticity measuring means for measuring chromaticity of light output emitted by the projected image displaying unit; and
second controlling means outputting second controlling signals instructing the first controlling means to output first control information for controlling the voltage varying means, based on the measurement of chromaticity outputted from the chromaticity measuring means.

In the thus constructed projected image displaying apparatus in accordance with the present invention, the first operating means calculates corrective data on each of the primary color components uniquely from the chromaticity at any coordinate points on the screen measured by the chromaticity measuring means. Thereafter, the thus calculated corrective data can be stored in the memory means in association with the coordinates of the points at which chromaticity has been measured. Therefore, it is possible to read out the corrective data repeatedly for reference or utilizing it for calculative operation.

The second operating means can calculate, based on the read-out first corrective data in association with a plurality of coordinate points from the memory means, second corrective data used for correctively modulating video signals to be applied to display elements emitting three primary color components in order to form picture elements at which no measurement of chromaticity was made.

The first and second corrective data calculated by the first and second operating means are constructed so that when a projected image is reproduced on the screen based on these data, both the first and second corrective data will not cause any color irregularity or unevenness one another. Therefore, it is possible to obtain projected images free from color unevenness by allowing the correctively modulating means to prepare video correcting signals for three primary color components from the total corrective data and modulate each of original video signals corresponding to respective three primary colors based on the prepared video correcting signals.

In accordance with a method for correcting color unevenness in a projected image displaying apparatus of the present invention, the first corrective data on each of the primary color components is calculated at second step uniquely from the chromaticity at arbitrary coordinate points measured at the first step. Thereafter, at fourth step, based on the first corrective data in association with a plurality of coordinate points calculated in the second step, calculation can be executed of the second corrective data used for correctively modulating video signals to be applied to display elements emitting three primary color components in order to form picture elements at which no measurement of chromaticity was made.

The first and second corrective data calculated in the second and fourth steps are constructed so that when a projected image is reproduced on the screen based on these data, both the first and second corrective data will not cause any color irregularity or unevenness one another. Therefore, it is possible to obtain projected images free from color unevenness at fifth step by preparing video correcting signals for three primary color components from the total corrective data and then modulating each of original video signals corresponding to respective three primary colors based on the prepared video correcting signals.

Further, in the projected image displaying apparatus of the present invention, the voltage varying means is capable of separately changing the amplitude voltages and bias voltages of video signals outputted by display elements. In addition, the controlling means may output control information for controlling the voltage varying means so as to allow the display elements to change the output amplitude voltage and bias voltage following proper procedures, to thereby obtain projected images having optimal chromaticity. Moreover, by virtue of the memory means, it is possible to keep the control information as non-volatile memory that allows the reproduction of the projected images having the optimal chromaticity.

The operation of the chromaticity adjusting system in the projected image displaying apparatus of the present invention can be descried as follows.

Initially, in the projected image displaying apparatus, the voltage varying means is capable of separately changing the amplitude voltages and bias voltages of video signals outputted by display elements. In addition, the first controlling means may output first control information for controlling the voltage varying means so as to allow the display elements to change the output amplitude voltage and bias voltage following proper procedures, to thereby obtain projected images having optimal chromaticity. Moreover, by virtue of the memory means, it is possible to keep the control information as non-volatile memory that allows the reproduction of the projected images having the optimal chromaticity.

Based on the measurement by the chromaticity measuring means on the chromaticity of light output from the projected image displaying apparatus, the second control means may output second controlling information to the first controlling means so as to instruct the first controlling means to output the first controlling information for controlling the voltage varying means.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a block diagram showing a circuit for generating video signals provided for a conventional liquid crystal display device;
Fig.2 is a circuit diagram showing an analog converting circuit shown in Fig.1;
Fig.3A is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3B is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3AA is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3C is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3D is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3CC is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3E is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.3F is a waveform diagram showing a projected image signal generated by the conversion in an analog converting circuit shown in Fig.2;
Fig.4A is a chart showing a relation between input and output in a logical circuit;
Fig.4B is a chart showing a relation between input and output in a logical circuit;
Fig.4C is a chart showing a relation between input and output in a logical circuit;
Fig.5 is a diagram showing positions of chromaticity measuring points on a liquid crystal display screen as an embodied example of the present invention.
Fig.6 is an illustrative view showing a positional relation of the optical arrangement in an embodiment of the present invention;
Fig.7 is a perspective view showing the structure of a liquid crystal projected image displaying device used for the means shown in Fig.6;
Fig.8 is a circuit block diagram used in an embodiment of the present invention;
Fig.9 is a diagram showing a positional relation on a liquid crystal display screen used in an embodiment of the present invention, and the relation between points at which chromaticity has been measured and points for which corrective data is calculated by the linear interpolation;
Fig.10 is circuit block diagram showing for organizing another embodiment of the present invention;
Fig.11 is a circuitry diagram of an analog converting circuit for used in the circuit shown in Fig.10;
Fig.12A is an illustrative view showing one relation of optical arrangement in the embodiment shown in Fig.10;
Fig.12B is an illustrative view showing another relation of optical arrangement in the embodiment shown in Fig.10;
Fig.13A is a waveform diagram showing a video signal used when chromaticity adjustment for "white" is conducted in the embodiment shown in Fig.10;
Fig.13C is a waveform diagram showing a video signal used when chromaticity adjustment for "white" is conducted in the embodiment shown in Fig.10;
Fig.13F is a waveform diagram showing a video signal used when chromaticity adjustment for "white" is conducted in the embodiment shown in Fig.10;
Fig.13B is a waveform diagram showing a video signal used when chromaticity adjustment for "white" is conducted in the embodiment shown in Fig.10;
Fig.14 is a chart showing an applied voltage-transmittance characteristic curve in a liquid crystal display device;
Fig.15 is a descriptive view of controlling procedures shown on the chromaticity chart when chromaticity adjustment for "white" is conducted in the embodiment shown in Fig.10;
Fig.16A is a table showing controlling procedures to be preset and corresponding colors to be controlled for respective regions on the chromaticity chart when the chromaticity for "white" is to be adjusted in the embodiment shown in Fig.10;
Fig.16B is a table showing controlling procedures to be preset and corresponding colors to be controlled for respective regions on the chromaticity chart when the chromaticity for "black" is to be adjusted in the embodiment shown in Fig.10;
Fig.17A is a waveform diagram showing a video signal used when chromaticity adjustment for "black" is conducted in the embodiment shown in Fig.10;
Fig.17C is a waveform diagram showing a video signal used when chromaticity adjustment for "black" is conducted in the embodiment shown in Fig.10;
Fig.17F is a waveform diagram showing a video signal used when chromaticity adjustment for "black" is conducted in the embodiment shown in Fig.10;
Fig.17B is a waveform diagram showing a video signal used when chromaticity adjustment for "black" is conducted in the embodiment shown in Fig.10; and
Fig.18 is a descriptive view of controlling procedures shown on the chromaticity chart when chromaticity adjustment for "black" is conducted in the embodiment shown in Fig.10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

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Initially, Fig.5 shows an example of chromaticity measuring points on a liquid crystal display screen shown as an example of an embodiment of the present invention, and Fig.6 is an illustrative view showing a positional relation of component used in the measurement. In this measurement, it is preferable to perform correction of dispersion of chromaticity in the liquid crystal display device under a circumstance allowing as great a transmittance of liquid crystal as possible. Therefore, the following operation of correction for chromaticity is to be made using a 'white' projected image for measuring light output in order to determine chromaticity distribution on the display image screen.

Designated at 33 in Fig.6 is an elemental array of a liquid crystal projected image displaying apparatus in accordance with an embodiment of the present invention, and this elemental array 33 has a structure as shown in Fig.7. The structure shown in Fig.7 includes color filters 40, liquid crystal 42, diodes 44, pixel electrodes 45, a pair of polarizing plates 47 and 50, and a pair of glass substrate 48 and 49. Here, reference numerals 43 and 46 denote white light rays emitted from a light source 32 and a scan line, respectively. As well known, one element is disposed in an area where one pixel electrode 45 occupies, and serves to present one color of three primary colors RGB. Three RGB color light beams emitted from three different elements each presenting one of RGB colors converge on a screen 1 to be recognized as one picture element.The brightness of each of RGB colors is controlled by varying the voltage applied to each pixel electrode 45 so as to change the transmittance of liquid crystal to thereby control the intensity of light that passes through the liquid crystal.

In Fig.6, reference numeral 34 designates an optical system composed of lenses and mirrors, etc., and serves to converge the RGB light on the screen 1. More specifically, white light emitted from the light source 32 passes through the liquid crystal projected image displaying elemental array 33, in which a number of light beam sets are formed such that each light beam set has RGB light components and is adjusted in light intensity to produce one picture element. The thus formed light beam sets containing RGB components are focalized on the screen 1 through the optical system 34 to form an image thereon. The thus formed image is observed by an user from an observing direction 35.

Unillustrated sensor portions of a chromaticity meter 36 locate at positions wherein picture elements on the screen 1 are to be measured on chromaticity. The chromaticity meter 36 measures chromaticity of the picture elements to be measured and outputs the data of the chromaticity measurement for each picture element to a liquid crystal projected image display elemental array controlling section 37 through a chromaticity data signal path 38. It should be noted that the chromaticity data signal path 38 can be formed of not only a wired means but also of a wireless means using such as infrared carrier wave signals, etc.

Referring next to Fig.5, a light beam set composed of RGB light components having passed through the liquid crystal projected image displaying elemental array 33 is projected on the-screen 1 so as to form a picture element a2 presenting a certain color specified by the video signal. A number of such picture elements a2 are arranged closely in both horizontal and vertical directions to form an image. Thus, the user recognizes composition of picture elements a2 arranged on the screen 1 as an image. In this image-forming, the liquid crystal projected image displaying elemental array 33 creating a projected image of picture elements a2 plays a major role but, it is impossible to manufacture a liquid crystal projected image displaying elemental array 33 which is completely free from variation of output light intensity in all the pixels. In other words, each pixel of the liquid crystal projected image displaying elemental array 33 inevitably differs more or less in output light intensity from the other part thereof, this variation in output light intensity causes picture elements a2 to be different in chromaticity, giving rise to color unevenness. Accordingly, controlling process of correcting color unevenness may be carried out as the following manner. First, a picture element 2 is selected equally from every micro-region composed of picture elements a2, and the thus selected picture elements 2 are measured on chromaticity. The measurement is fed back to the video signals applied to the three liquid crystal projected image display devices forming respective RGB colors.By this feed back, the video signals for producing the rest unselected picture elements a2 are corrected so that the light output may be increased or decreased, to thereby eliminate chromaticity difference among picture elements a2.

In the selection of picture elements 2 to be measured, horizontal lines 3 arranged at a certain interval and vertical lines 4 arranged at a certain interval are formed, and picture elements occupying in the intersecting points therebetween arranged as lattice points may be selected as picture elements 2 to be measured on chromaticity. The chromaticity meter 36 is constructed such that a chromaticity meter element locates at each of the thus selected picture elements 2 and measures the chromaticity. Here, a picture element 2 measured on chromaticity will be represented by coordinate point (U, W), and each measurement of chromaticity is stored in association with its coordinate pint (U, W), and will be used for calculative operation.

Now, description will be made of the correcting method of the video signals applied to the three liquid crystal projected image display devices which form respective RGB colors in order to produce the rest unselected picture elements a2 based on the feed back of the measurement of chromaticity. First of all, from the chromaticity measured for each picture element 2, corrective data at the point as to each RGB color is calculated. Then, corrective data on each RGB color for a picture element a2 at which no measurement on chromaticity was made is calculated by effecting a linear interpolating approximation on the basis of corrective data on each RGB color for the nearest four grid points enclosing the picture element a2.

Next, description will be made on the calculation for determining corrective data on each of G, B and R signals at a measured picture element 2 from the chromaticity data measured at the picture element 2.

chromaticity measurement data (x, y), corrective data <G>, <B> and <R> can be uniquely defined by the following expressions:-

"(1)" <G> = ax + by

"(2)" <B> = cx + dy

"(3)" <R> = ex + fy

where a, b, c, d, e and f are constants.

Here, it should be noted that all the corrective data <G>, <B> and <R> mentioned above can also be determined by a calculating means outside the apparatus.

Fig.8 shows a block circuit diagram used in a first embodiment of the present invention. With reference to Fig.8, description will be made in detail on a calculation process of determining three RGB color corrective data for forming a picture element a2g shown in Fig.9, based on the fed back corrective data <G>, <B> and <R> obtained as above. The thus determined RGB color corrective data are used to correct the three video signals respectively applied to three liquid crystal projected image display elements respectively serving to display RGB colors to be composed so as to form a picture elements a2g.

A corrective data writing circuit 5 picks up chromaticity measurement (x, y) by the chromaticity meter 36 for a picture element 2 at the coordinates (U, W) on the screen 1, and calculates corrective data <G>, <B> and <R> based on the formulae (1), (2) and (3) to store the result into respective corrective data memories 7, 8 and 9. At the same time, the corrective data writing circuit 5 generates address information AD {(U, W)} corresponding to the coordinates (U, W) of the picture element 2 on the screen, to output the address information together with the calculated corrective data <G>, <B> and <R> to the corrective data memories 7, 8 and 9.

A corrective data storing section 28 is composed of corrective data memories 7, 8 and 9, and receives addresses AD {(U.W)} from the corrective data writing circuit 5, each of which designated an address in corresponding corrective data memory 7, 8 or 9. The corrective data storing section 28 is also fed with the corrective data on each chromaticity <G>, <B> and <R> from the same corrective data writing circuit 5, and stores the chromaticity data in the above-designated addresses AD {(U.W)}.

Based on synchronizing signals H, V and clock signal CK for the video signals for display, inputted through respective terminals 19, 20 and 21, a memory address generating circuit 6 recognizes the coordinates (U, W) of a picture element a2 expected next to be reproduced as a projected image pixel.

Now, consider, as an example, the case where the circuit 6 recognized that a picture element a2g existing at a coordinate point (Ug, Wg) shown in Fig.9 is expected next to be reproduced. In this case, in order to produce the picture element a2g, it is necessary to determine correcting signals Sg, Sb and Sr for correctively modulating original video signals SEg, SEb and SEr to be applied to liquid crystal in respective three liquid crystal projected image display elements respectively serving to display RGB colors.In order to calculate the signals Sg, Sb and Sr, corrective data on neighboring four picture elements 2a at (Ua, Wa), 2b at (Ub, Wb), 2c at (Uc, Wc) and 2d at (Ud, Wd) enclosing a point (Ug, Wg) are required, therefore, the memory address generating circuit 6 generates addresses AD {(Ua, Wa)}, AD {(Ub, Wb)}, AD {(Uc, Wc)} and AD {(Ud, Wd)} on a corrective data storing section 28 in which corrective data <G>, <B> and <R> for the neighboring four picture elements 2a, 2b, 2c and 2d are stored. The thus generated addresses are outputted to the corrective data storing section 28. Accordingly, the following relations hold.

"(4)" Ua = Uc </= Ug </= Ub = Ud

"(5)" Wa = Wc >/= Wg >/= Wb = Wd

Correcting data interpolation processing circuits 10, 11 and 12 calculate corrective data <G>, <B> and <R> for the picture element a2g, respectively by executing linear interpolating operation using corrective data <G>, <B> and <R> for the four picture elements 2 that enclose the picture element a2g as in the following way and outputs the result to D/A converters 13, 14 and 15, respectively.

As an example, calculations in the liner-interpolating process as to corrective data on G-signals will be described. A corrective data memory 7 for corrective data on G-signals holds corrective data <Ga>, <Gb>, <Gc> and <Gd> for picture elements 2a at (Ua, Wa), 2b at (Ub, Wb), 2c at (Uc, Wc) and 2d at (Ud, Wd) in addresses AD {(Ua, Wa)}, AD {(Ub, Wb)}, AD {(Uc, Wc)} and AD {(Ud, Wd)}, respectively. When these addresses AD {(Ua, Wa)}, AD {(Ub, Wb)}, AD {(Uc, Wc)} and AD {(Ud, Wd)} are inputted from the memory address generating circuit 6, the memory 7 in turn sends out the corrective data <Ga>, <Gb>, <Gc> and <Gd> to a corrective data interpolation processing circuit for G-signals 10.

Since the relations (4) and (5) hold on the screen 1, it is possible to assume that the picture elements 2b and 2c exist at kth places rightward, respectively, from the picture elements 2a and 2c. The picture elements 2c and 2d are assumed to exist at nth places downward, respectively, from the picture elements 2a and 2b.Further, corrective data on G-signal at each point in Fig.9 will be assumed as follows:-

<Ge> : corrective data on G-signal at a picture element a2e designated by the coordinates (Ue, We) existing at mth place downward from the picture element 2a;

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place downward from the picture element 2b; and

<Gg> : corrective data on G-signal at the picture element a2g designated by the coordinates (Ug, Wg) existing at jth place rightward from the picture element a2e.

In this assumption, <Ge>, <Gf> and <Gg> are given as the following expressions:-

"(6)" <Ge> = {(<Ga> - <Gc>)/n} x m + <Ga>

"(7)" <Gf> = {(<Gb> - <Gd>)/n} x m + <Gd>

"(8)" <Gg> = {(<Gf> - <Ge>)/k} x j + <Ge>

Here, the following relations hold:-

Ua = Uc = Ue, Ub = Ud = Uf;

Ua + j = Ug, Ua + k = Ub;

Wa = Wb, Wc = Wd, We = Wf = Wg; and

Wa = Wc + n = We + m.

The corrective data interpolation processing circuit for G-signals 10, based on the formulae (6), (7) and (8) calculates corrective data <Ge>, <Gf> and <Gg> for G-signals for correcting chromaticity values of the picture elements a2e, a2f and a2g present, respectively, at points (Ue, We), (Uf, Wf) and (Ug, Wg), to output the result to the D/A converter 13. For the picture elements 2 at which the measurement of chromaticity has been effected, there is no need for calculating corrective data <G> by the linear interpolation. Therefore, the corrective data stored in the corrective data storing section 28 can be used as it is.

Correcting data <B> and <R> for B-signals and R-signals can be calculated using the same linear interpolating process.

A D/A converting section 30 is composed of D/A converters 13, 14 and 15, which receive corrective data <G>, <B> and <R> at the picture elements 2 and a2 as digital data, convert them into correcting signals Sg, Sb and Sr having analog values, send the result to amplifiers 16, 17 and 18, respectively.

In a correctively modulating section 31, the amplifier 16 receives an original video signal SEg to be applied to the liquid crystal projected image display device for displaying G-color through a terminal 22. In the same manner, the amplifier 17 receives an original video signal SEb to be applied to the liquid crystal projected image display device for displaying B-color through a terminal 23, and the amplifier 18 receives an original video signal SEr to be applied to the liquid crystal projected image display device for displaying R-color through a terminal 24.These signals are correctively modulated in amplitude through amplification in accordance with correcting signals Sg, Sb and Sr supplied from the D/A converting section 30, and the resultant video signals SLg, SLb and SLr are outputted from terminals 25, 26 and 27 to be applied to respective liquid crystal elements of the liquid crystal projected display devices forming GBR colors.

As described heretofore, chromaticity of picture elements for reproducing the projected image is successively corrected, so that dispersion of chromaticity over the entire image may be eliminated.

Fig.10 shows a block circuit diagram for embodying another embodiment of the present invention. In this figure, gamma -correction circuits 55r, 55g and 55b are all identical (therefore, will be generally referred to as " gamma -correction circuit 55), and analog circuits 56r, 56g and 56b are all composed of an identical analog converting circuit 56 shown in Fig.11. With regard to the flow of the video signals, the same flow of signals as described in Figs.1 and 2 will be allotted with identical reference numerals, and the description thereof will be omitted.

Figs.12A and 12B show relations of optical arrangement of elements employed in the embodiment. Since each of the elements has the same function as in Fig.6, the description will be omitted by allotting the same reference numerals. As shown in the figures, there can be considered two kinds of optical arrangements. A case shown in Fig.12A is arranged such that the image having passed through the transparent screen 1 is sensed by the chromaticity meter 36 or the user from an observing position 35. Another case shown in Fig.12B is arranged such that the image formed on the screen 1 by means of the optical system 34 is sensed by the chromaticity meter 36 or the user from an observing position 35.

Referring to Figs.10 and 11, description of the procedures for adjusting chromaticity for white will be made. Waveforms of video signals appearing herein are shown in Figs.13A, 13B, 13C and 13F. Input signal S8 in the logical circuit 62 and output digital video signal data D0, D1, D2, ... are graphed in Figs.4A to 4C. A micro-computer 51 outputs a control signal S3 to a system micro-computer 52, which, in turn, based on the control signal S3 received from the micro-computer 51, outputs a signal S6 represented by a waveform shown in Fig.13B to the logical circuit 62, switches SW1, SW2 and SW3.

A gamma -correction converting table (not shown) on the gamma -correcting circuit 55 is composed of random access memories (to be referred to 'RAM' hereinafter) so as to facilitate the system micro-computer 52 to rewrite the

constant data value FFH shown in Fig.13A, regardless of the magnitude of the digital video signal S8 inputted as shown in the graph in Fig.4A. This structure eliminates the necessity of providing a particular, separate signal generator. Of course, equivalent structures may be allowed by providing other means, for example, by using a signal generator capable of controlling the system.

Here, a D/A converter 60 varies the full-scale voltage VFS on the basis of a bias voltage inputted through an input terminal VREF as a reference voltage, and outputs a signal S10 having the full-scale voltage VFS as a level thereof in accordance with the instruction of a control signal S7 inputted at input terminal CTRL from the system microcomputer 52. The thus formed output signal S10 is sent to a terminal 'a' of a switch SW1. In the similar manner, a D/A converter 61 varies the offset voltage VOF on the basis of a bias voltage inputted through an input terminal VREF as a reference voltage, and outputs a signal S15 having the offset voltage VOF as a level thereof in accordance with the instruction of the control signal S7 inputted at an input terminal CTRL from the system micro-computer 52.The output signal S15 is sent to terminal 'a' of a switch SW2 and terminal 'b' of a switch SW3.

In this while, the D/A converter 59 which receives the digital video signal S8 and the control signal S6 as well as accepts the signal S10 having a waveform kept always at the full-scale voltage VFS via an input terminal VREF for reference voltage, outputs a video signal S9 having a waveform shown in Fig.13C that is composed of the sum of waveforms shown in Fig.13A and Fig.13B toward a (+)terminal of an amplifier AMP 1. Accordingly, the analog converter 56 will output an video signal S14 having a waveform shown in Fig.13F or a pulsing waveform having amplitude equal to the offset voltage VOF with a reference voltage of 0V, regardless of the full-scale voltage VFS.

In controlling the offset voltage VOF, which determines the amplitude of the video signal S14, the system microcomputer 52, receiving the control signal S3 outputted from the micro-computer 51 and based on this signal, outputs the control signal S7 to a CTRL terminal of the D/A converter 61 present in each analog converters 56 so as to vary the magnitude of the offset voltage VOF outputted from a VOUT of the D/A converter 61. Meanwhile, as the control signal S7 is also supplied to a CTRL terminal of the D/A converter 60, the system must be designed so as to vary only the output offset voltage VOF from the D/A converter 61 without varying the full-scale voltage VFS outputted from the VOUT terminal of the D/A converter 60. Such controlling method is disclosed, for example, in IEEE-STD-488.

Fig.14 is a plot showing a relation between applied voltage to liquid crystal and transmittance thereof for adjusting chromaticity of white. In the figure, the axis of abscissa represents applied voltage and the axis of ordinate represents transmittance of liquid crystal. Specifically, when the applied voltages are at VW0, VW1, VW2, VW3, VB3, VB2, VB1 and VB0, the transmittance will become TW0, TW1, TW2, TW3, TB3, TB2, TB1 and TB0, respectively.

As the offset voltage VOF which is equal to the amplitude of the video signal S14 applied to the liquid crystal is controlled to be as low as VW3 by operating the analog converting circuit 56, the transmittance of the liquid crystal becomes enough high to present increased light output RAY from the liquid crystal display device/optical converting section 57. In contrast, as understood from Fig.14, when the applied voltage takes a value around VW3, the transmittance varies considerably largely with variation of the applied voltage, so that gradation is hard to produce, and therefore, error arising in quantization of transmittance of liquid crystal tends to become large as the transmittance is adjusted by the gamma -correction.

On the other hand, if a little bit higher voltage is applied so that the offset voltage VOF may be equal to VW0, as understood from Fig.14, variation in transmittance with the change of applied voltage is small in the vicinity of the voltage VW0, so that gradation is easy to produce, but the light output RAY by the liquid crystal display device/optical converting section 57 is too small, resulting in poor contrast.

The adjustment to an optimal voltage which allows easiness of producing gradation and proper brightness and contrast has been carried out empirically, but this embodiment leaves the adjustment to the micro-computer 51. More specifically, the micro-computer 51 outputs the control signal S3 for controlling procedures for producing gradation, and based on the control signal S3 the system micro-computer 52 outputs control signals S7 to the analog converting circuit 56. The analog converting circuit 56, based on the control signal S7, varies the video signal S14 representing the applied voltage to the liquid crystal within a range of from VW1 to VW3 so that the transmittance of the liquid crystal may be optimal between TW1 and TW3. The thus selected optimal value is outputted.This control is effected in the same manner for each of three RGB colors, independently, so as to select a condition wherein all the three colors present the best contrast and gradation.

Fig.15 is a chromaticity chart. With reference to the figure, procedures to effect chromaticity adjustment will be explained. First of all a target chromaticity point defining "white" is assumed to be designated by the coordinates (Xtyp1, Ytyp1) on the chromaticity chart. A chromaticity meter 58 measures the chromaticity of unadjusted light output RAY and outputs the measurement as a data signal S2 to the micro-computer 51. The thus obtained chromaticity will be assumed to be designated by (X, Y) on the chromaticity chart. This point (X, Y) must belong to any one of regions 1), 2) and 3). In order to deal with any possible chromaticity measured, a series of processing procedures is to have been determined in advance for each region, and the software for controlling the operation is to have been programmed in the micro-computer 51.

If the measured chromaticity point (X, Y) lies in the region 1), this status is recognized by the micro-computer 51 as the following expression:-
"(9)" X >/= Xtyp1, and Y >/= Ytyp1

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If the measured chromaticity point (X, Y) lies in the region 2), this status is recognized by the micro-computer 51 as the following expression:-
"(10)" X < Xtyp1, and Y >/= X

Alternatively, if the measured chromaticity point (X, Y) lies in the region 3), this status is recognized by the micro-computer 51 as the following expression:-
"(11)" X > Y, and Y < Ytyp1

Fig.16A is a table showing controlling procedures to be preset and corresponding colors to be controlled for respective regions on the chromaticity chart when the chromaticity for "white" is to be adjusted.

As an example, if a point (X, Y) satisfying the condition (9) is recognized by the micro-computer 51, the step 1 in the row for the region 1) in Fig.16A teaches to perform adjustment of G-color. Therefore, in order to bring Y (>/= Ytyp1) close to Ytyp1, G-component in light output RAY must be reduced, or the applied voltage to the liquid crystal is to be taken large so as to increase the amplitude of the video signal S14. To achieve this, the microcomputer 51 sends for the system micro-computer 52 a signal S3 so as to increase the offset voltage VOF in the analog converting circuit 56g for G-component to thereby increase the amplitude just mentioned.The system micro-computer 52, having received the signal S3, sends out for the analog converting circuit 56g the signal S7 to thereby increase the offset voltage VOFto be outputted as an output voltage VOUT of the D/A converter 61 simultaneously.

By the control operation described above, as G-component of the light output RAY becomes small, the chromaticity meter 58 detects that the Y-coordinate of the chromaticity reduces. The micro-computer 51 recognizes this information through the output signal S2. The above series of procedures will be repeated until Y-value of the chromaticity measurement agrees with Ytyp1 of the point (Xtyp1, Ytyp1) defined as "white".

Next, referring again to Fig.16A, the step 2 in the row for the region 1) specifies to execute adjustment of R-color. Therefore, in order to bring X (>/= Xtyp1) close to Xtyp1, R-component in the light output RAY must be reduced, or the applied voltage to liquid crystal is to be taken large. To achieve this, the micro-computer 51 sends for the system micro-computer 52 the signal S3 so as to increase the offset voltage VOFin the analog converting circuit 56r for R-component. Then, the same control sequence as executed above for G-component of the light output RAY is to be made, and the series of procedures will be repeated until X-value of the chromaticity measurement agrees with Xtyp1 of the point (Xtyp1, Ytyp1) defined as "white".

If the intermediately modified point reaches other chromaticity region in the way of the controlling operation, the control will be made following the procedures previously set up for the region.

Referring to Figs.10 and 11 description of the procedures for adjusting chromaticity for black will be made. Waveforms of video signals appearing herein are shown in Figs.17A, 17B, 17C and 17F. The system micro-computer 52, based on the control signal S3 received from the microcomputer 51, outputs a signal S6 represented by a waveform shown in Fig.17B to the logical circuit 62, switches SW1, SW2 and SW3.

The gamma -correction converting table on the gamma -correcting circuit 55 composed of RAM's allows the digital video signal data D0, D1, D2, ... to be set up to indicate a waveform having a constant data value OOH shown in Fig.17B, regardless of the magnitude of the digital video signal S8 inputted as shown in the graph in Fig.4B.

The D/A converter 59 which receives the digital video signal S8 and the control signal S6 as well as accepts the signal S10 having a waveform kept always at the full-scale voltage VFS via an input terminal VREF for reference voltage, outputs a video signal S9 having a waveform shown in Fig.17C that is composed of the sum of waveforms shown in Fig.17A and Fig.17B toward the (+)terminal of the amplifier AMP 1. Accordingly, the video signal S14 which the analog converter 56 outputs has a waveform shown in Fig.17F or a pulsing waveform having amplitude equal to the sum of the offset voltage VOFand the full-scale voltage VFS with a reference voltage of 0V. Since the offset voltage VOF has been already determined when the chromaticity for white was adjusted, it cannot be varied. Therefore, the amplitude of the video signal S14, or the sum of VOFand VFS depends on the full-scale voltage VFS.

In controlling the full-scale voltage VFS, the system micro-computer 52, receiving the control signal S3 outputted from the micro-computer 51 and based on this signal, outputs the control signal S7 to the CTRL terminal of the D/A converter 60 present in each analog converters 56 so as to vary the magnitude of the full-scale voltage VFS outputted from a VOUT of the D/A converter 60. Meanwhile, as the control signal S7 is also supplied to the CTRL terminal of the D/A converter 61, the system is designed so as to vary only the output full-scale voltage VFS from the D/A converter 60 without varying the offset voltage VOFoutputted from the VOUT terminal of the D/A converter 61.

Subsequently, chromaticity adjustment to black will be described with reference to Fig.14 which graphs the relation between applied voltage to liquid crystal and transmittance thereof for adjusting chromaticity.

As the sum of the offset voltage VOFand the full-scale voltage VFS which is the amplitude of the video signal S14 to be applied to liquid crystal is controlled to be as high as VB3, the transmittance of liquid crystal becomes enough low to present reduced light output RAY from the liquid crystal display device/optical converting section 57. In contrast,

largely with variation of the applied voltage, so that gradation is hard to produce, and therefore, error arising in quantization of transmittance of liquid crystal tends to become large as the transmittance is adjusted by the gamma-correction.

On the other hand, if a little bit higher voltage is applied so that the sum of the offset voltage VOF and the full-scale voltage VFS may be equal to VW0, as understood from Fig.14, variation in transmittance with the change of applied voltage is small in the vicinity of the voltage VB0, so that gradation is easy to produce, but the light output RAY by the liquid crystal display device/optical converting section 57 is too great, resulting in poor contrast.

This adjustment also is left to the micro-computer 51. More specifically, the analog converting circuit 56, based on the control signal S7, varies the video signal S14 representing the applied voltage to the liquid crystal within a range of from VB1 to VB3 so that the transmittance of the liquid crystal may be optimal between TB1 and TB3. The thus selected optimal value is outputted. This control is effected in the same manner for each of three RGB colors, independently, so as to select a condition wherein all the three colors present the best contrast and gradation.

Next, Fig.18 shows a chromaticity chart. With reference to the figure, procedures to effect chromaticity adjustment will be explained. First of all a target chromaticity point defining "black" is assumed to be designated by the coordinates (Xtyp2, Ytyp2) on the chromaticity chart. The chromaticity meter 58 measures the chromaticity of unadjusted light output RAY and outputs the measurement as a data signal S2 to the micro-computer 51. The thus obtained chromaticity will be assumed to be designated by (X, Y) on the chromaticity chart. This point (X, Y) must belong to any one of regions 4), 5) and 6). In order to deal with any possible chromaticity measured, a series of processing procedures is to have been determined in advance for each region, and the software for controlling the operation is to have been programmed in the microcomputer 51.

If the measured chromaticity point (X, Y) lies in the region 4), this status is recognized by the micro-computer 51 as the following expression:-
"(12)" X </= Xtyp2, and Y </= Ytyp2

If the measured chromaticity point (X, Y) lies in the region 5), this status is recognized by the micro-computer 51 as the following expression:-
"(13)" X </= Y and Y >/= Ytyp2

Alternatively, if the measured chromaticity point (X, Y) lies in the region 6), this status is recognized by the micro-computer 51 as the following expression:-
"(14)" X > Y, and Y > Xtyp2

Fig.16B is a table showing controlling procedures to be preset and corresponding colors to be controlled for respective regions on the chromaticity chart when the chromaticity for "black" is to be adjusted.

As an example, if a point (X, Y) satisfying the condition (12) is recognized by the micro-computer 51, the step 1 in the row for the region 4) in Fig.16B teaches to perform adjustment of G-color. Therefore, in order to bring Y (</= Ytyp2) close to Ytyp2, G-component in light output RAY must be increased, or the applied voltage to the liquid crystal is to be made small so as to reduce the amplitude of the video signal S14. To achieve this, the microcomputer 51 sends for the system micro-computer 52 a signal S3 so as to increase the offset voltage VOF in the analog converting circuit 56g for G-component to thereby reduce the amplitude just mentioned.The system micro-computer 52, having received the signal S3, sends out for the analog converting circuit 56g the signal S7 to thereby reduce the offset voltage VOF to be outputted as an output voltage VOUT of the D/A converter 61 simultaneously.

By the control operation described above, as G-component of the light output RAY becomes large, the chromaticity meter 58 detects that the Y-coordinate of the chromaticity increases. The micro-computer 51 recognizes this information through the output signal S2. The above series of procedures will be repeated until Y-value of the chromaticity measurement agrees with Ytyp2 of the point (Xtyp2, Ytyp2) defined as "black".

Next, referring again to Fig.16B, the step 2 in the row for the region 4) specifies to execute adjustment of R-color. Therefore, in order to bring X (</= Xtyp2) close to Xtyp2, R-component in the light output RAY must be increased, or the applied voltage to liquid crystal is to be made small. To achieve this, the micro-computer 51 sends for the system micro-computer 52 the signal S3 so as to reduce the offset voltage VOF in the analog converting circuit 56r for R-component. Then, the same control sequence as executed above for G-component of the light output RAY is to be made, and the series of procedures will be repeated until X-value of the chromaticity measurement agrees with Xtyp2 of the point (Xtyp2, Ytyp2) defined as "black".In this connection, if the intermediately modified point reaches other chromaticity region in the way of the controlling operation, the control will be made following the procedures previously set up for the region.

When the control described above has been accomplished, the 51 send out for the 52 a control signal S3 which indicates that the values of control signals S7 representing respective optimum offset voltage VOF and full-scale voltage VFS for each color should be stored so as to reproduce these values at any time. The 52, in accordance with the control signal S3 inputted, outputs a data signal S5 bearing the information on the values of control signals S7 to

maintained without vanishing, and will be read out as required as a data signal S4 to reproduce optimal offset voltages VOF and full-scale voltages VFS.

The transmission of the control signal S3 from the 51 to 52 can be effected by not only wired means but also by wireless means such as using infrared carrier wave signals, etc.

Since a typical projecting apparatus includes a 52 as standard equipment, it is sufficient to manipulate the software as to the control of the present invention and there is need for particular parts to be built in.

Further, it is possible to omit the 51 by providing a 52 that is enough effective to discharge the functions of the 51. In this configuration, measurement by the chromaticity meter 58 on chromaticity of the light output RAY can be directly accepted by 52, so that it is possible to realize a system at low cost still working more rapidly.

Although the above description has been made of an embodiment using liquid crystal devices, this should be taken as a mere example, and the present invention can be applied to other display devices such as a CRT in place of liquid crystal devices.

In accordance with the present invention, corrective data on each of the primary colors is formulated by the linear interpolating technique so that a projected image reproduced based on the corrective data exhibits little chromaticity difference between neighboring picture elements formed by the display elements. Accordingly, when the entire corrective data is used to prepare video correcting signals having analog values for each of the primary colors and original video signals having analog values for each of the primary colors are modulated based on the obtained video correcting signals, it is possible to inhibit dispersed distribution on the display screen which would be caused by the dispersion of the display elements and therefore it is possible to obtain a projected image free from color unevenness.

Further, in accordance with the present invention, it is possible to markedly reduce the operations required for chromaticity adjustment by the operators and it is possible to assure rapid adjustment of chromaticity, regardless of the operator's skill.

Since few additional external equipments such as circuits and connections are needed, the cost hardly rises.

Since the projected image display apparatus retains the optimal chromaticity adjusted at the time of manufacture, even if a user misuses the apparatus, there is no risk that the adjusted chromaticity might become out of fix so as not to recover. Therefore, highly increased reliability of the apparatus can be established.

A projected image displaying apparatus and a method of correcting color unevenness therein

Claims of correspondent: EP0595649

1. A projected image displaying apparatus for forming images by projecting on a screen three kinds of lights corresponding to the primary color components of video signals, comprising:
chromaticity measuring means for measuring chromaticity at arbitrary coordinate points on said screen;
first operating means for calculating first corrective data on each of the primary color components uniquely from the chromaticity at the coordinate points measured by said chromaticity measuring means;
memory means for storing said first corrective data in association with the coordinates of the points at which chromaticity has been measured;;
second operating means reading out said first corrective data in association with a plurality of coordinate points from said memory means and calculating, based on the read-out first corrective data, second corrective data used for correctively modulating video signals to be applied to display elements emitting three primary color components in order to form picture elements at which no measurement of chromaticity was made; and
correctively modulating means, preparing video correcting signals for three primary color components based on said first and second corrective data calculated by said first and second operating means and modulating original video signals with said prepared video correcting signals.

2.A method for correcting color unevenness in a projected image displaying apparatus for forming images by projecting on a screen three kinds of lights corresponding to the primary color components of video signals, comprising the steps of:
measuring chromaticity at arbitrary coordinate points on said screen (first step);
calculating first corrective data on each of the primary color components uniquely from the chromaticity at the coordinate points measured in the first step (second step);
storing said first corrective data into memory means in association with the coordinates of the points at which chromaticity has been measured (third step);;
reading out said first corrective data in association with a plurality of coordinate points from said memory means and calculating, based on the read-out first corrective data, second corrective data used for correctively modulating video signals to be applied to display elements emitting three primary color components in order to form picture elements at which no measurement of chromaticity was made (fourth step); and
preparing video correcting signals for three primary color components based on said first and second corrective data calculated in the second and fourth steps and modulating original video signals by said prepared video correcting signals (fifth step).

3.A projected image displaying apparatus according to claim 1, further comprising:
voltage varying means capable of separately changing the amplitude voltages and bias voltages of video signals outputted to said display elements;
controlling means outputting control information for controlling said voltage varying means; and
memory means storing the control information outputted from said controlling means.

4.A projected image displaying apparatus, comprising:
a projected image displaying unit which comprises:
voltage varying means capable of separately changing the amplitude voltages and bias voltages of video signals outputted to display elements;
first controlling means outputting first control information for controlling said voltage varying means; and
memory means storing the first control information outputted from said first controlling means, and
a chromaticity adjusting system which comprises:
chromaticity measuring means for measuring chromaticity of light output emitted by said projected image displaying unit; and
second controlling means outputting second controlling signals instructing said first controlling means to output first control information for controlling said voltage varying means, based on the measurement of chromaticity outputted from said chromaticity measuring means.

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[19]中华人民共和国专利局

[11] 公开号 CN 1092233A

[12] 发明专利申请公开说明书

[21]申请号 93114121.4

[51]Int.Cl[5]
H04N 9／43

[43]公开日 1994 年 9 月 14 日

[22]申请日 93.10.30

[30]优先权

[32]92.10.30[33]JP[31]292621／92

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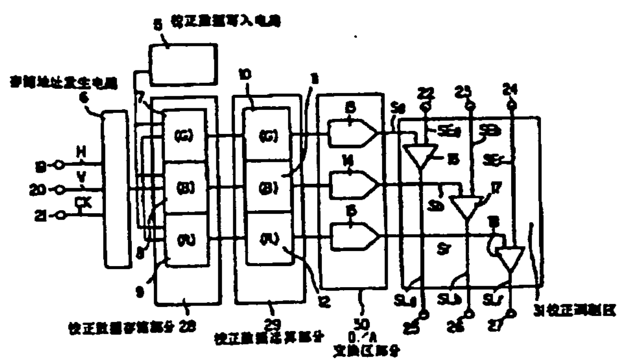
H04N 9／68 H04N 5／74
G02F 1／13

说明书页数: 附图页数:

[54]发明名称 投影图象显示装置和校正其色不均匀性的方法

[57]摘要

由色度仪测量所选各象素的光输出色度。从测量值计算 RGB 各色的校正数据，此数据又用于计算未选象素处 RGB 各色的校正数据。用此法，RGB 各色的原始视频信号将根据这样获得的校正数据受到校正调制。投影图象显示装置这样构成，以致从色度仪对整个图象的色度测量值有关白色及黑色的色度调节是由使用微机的自动控制一致而可靠地完成的，从而确定校正调制原始视频信号的最佳状态。这装置还包括将该最佳状态存入非易失存储器中的装置。



1. 一种通过将与视频信号的基色分量相对应的三种光投影到屏上形成图象的投影式图象显示装置，它包括：

色度测量装置，用于测量所述屏上任意坐标的色度；

第一运算装置，用于从由所述色度测量装置测量的该坐标点的色度单值地计算每个基色发量的第一校正数据；

存储装置，用于存储与已测量色度的点的座标一起的所述第一校正数据；

第二运算装置，从所述存储装置读出与若干坐标点结合的所述第一校正数据，根据读出的第一校正数据计算用于校正调制要加在发射三基色分量的显示单元上视频信号的第二校正数据，从而形成未进行色度测量的象素；和

校正调制装置，根据由所述第一和第二运算装置计算的所述第一和第二校正数据，准备用于三基色分量的视频校正信号，并用所述准备的视频校正信号调制原始视频信号。

2. 一种用于将与视频信号的基色分量对应的三种光投影到屏上形成图象的投影式图象显示装置中校正色不均匀性的方法，该方法包括如下步骤：

测量所述屏上任意坐标点的色度（第一步）；

从在第一步测得的该坐标点的色度单值计算每个基色分量的第一校正数据（第二步）；

与已测量色度的该点的坐标一起将所述第一校正数据存入存储器装置（第三步）；

从所述存储器装置读出与若干坐标结合的所述第一校正数据，并根据读出的第一校正数据计算用于校正调制要加到发射三基色分量的

显单元上的视频信号的第二校正数据，从而形成未进行色度测量的象素(第四步) ；和

根据在第二和第四步计算的所述第一和第二校正数据准备用于三基色分量的视频校正信号，并用所述准备的视频校正信号调制原始视频信号(第五步) 。

3.依照权利要求1的投影式图象显示装置，其特征在于，还包括:

电压变化装置，能独立地改变输出至所述显示单元的视频信号的幅度电压和偏置电压;

控制装置，输出控制信息用以控制所述电压变化装置；和

存储装置，存储从所述控制装置输出的控制信息。

4.一种投影式图象显示装置，包括:

投影式图象显示单元，该单元包括以下:

电压变化装置，该装置能分别地改变输出至显示单元的视频信号的幅度电压和偏压电压;

第一控制装置，该装置输出第一控制信息用于控制电压变化装置；和

存储装置，该装置存储从第一控制装置输出的第一控制信息，和

色度调节系统，该系统包括:

色度测量装置，用于测量由所述投影式图象显示单元发出的光的色度；和

第二控制装置，输出指令所述第一控制装置去输出第一控制信息的第二控制信号用以根据从所述色度测量装置输出的色度测量值控制所述电压变化装置。

投影图象显示装置
和校正其色不均匀性的方法

本发明涉及使用若干个显示器件的投影图象显示装置，本发明还涉及在整个显示图象上色不均匀性可从被校正的投影图象显示装置中校正色不均匀性的方法和在生产阶段等被执行的能自动实现色度调节的显示装置。

在使用若干个显示器件的投影图象显示装置中，需要严格控制显示单元的特性，从而建立遍及整个显示图象的色度均匀性，但是遍及投影图象的色度随位置而变化，这取决于所使用光源的色再现特性，光源所使用的色分离／组合系统和显示元件的透射系数分布和其他因素，因此从技术观点看要在投影图象显示装置中建立这样严格的控制是非常困难的。

在称为“白平衡调节方法”的一种方法中，视频信号由红、兰和绿分量的视频信号组成（下文分别称为R信号、B信号和G信号），每种分量的幅度是可变的以便实现增益控制，从而可以在遍及整个图象上粗略地调节色度。

已公开的日本专利申请昭和63 NO.37785揭示了一种对由若干个液晶显示屏排列构成的象屏的情况下引起亮度和色度不均匀性的校正方法。这方法包括以下几步：在其实际安装状态测量每个液晶显示屏的光强，依据所获得的光强，产生每个液晶显示屏的亮度均匀性比的数据，从而将产生的数据存入存储器；依据每个液晶显示屏上存储数据和投影图象数据进行计算操作，从而显示均匀的投影图象。

现在，结合图1说明传统的色度测量方法，图1是产生供给典型的

液晶显示器件的视频信号的电路的方块图。在此图中γ 校正电路55r、55g和55b结构相同，而模拟转换电路56r、56g和56b也与图2所示的模拟转换电路56的结构一样。

有模拟值的视频信号S1被送入投影图象处理部分54，在其中输入数据被分离为R信号、G信号和B信号。这样分离后的信号通过投影图象处理部分54中A／D变换电路54r、54g和54b形成量化数字视频信号、S1R、S1G和S1B，这些信号又依次送出至γ 校正电路55r、55g和55b。

γ 校正电路55r、55g和55b是为了补偿液晶的电压－透射特性而执行γ 校正的，使分别输入的数字视频信号S1R、S1G和S1B经过γ 校正，将数字视频信号Sγ R、Sγ G和Sγ B分别输出至模拟变换电路56r、56g和56b。

模拟变换电路56r、56g和56b分别将输入的数字视频信号Sγ R、Sγ G和Sγ B变换为模拟值。这样形成的模拟值作为视频信号SR、SG和SB送出至液晶显示器／光学变变换部分57。

液晶显示器／光学变换部分57根据输入的视频信号SR、SG和SB，重现图象和发出光输出RAY。

色度仪接收来自液晶显示器／光学变换部分57的作为图象发出的光输出RAY，测量其色度，以指示测量值。这里，为说明方便，假定所使用的液晶显示器为标准白类型，更明白地说，假定液晶显示器的透射比随着所加电压增加而减小。还假定显示器由中心电压为地电平和对每水平行变化极性的交变电压所驱动。

下面，说明模拟变换电路56r、56g和56b中信号波形的变换程序。图2是模拟变换电路56的电路图。图1所示图中有三个模拟变换电路56，即用于处理R信号的模拟变换电路56r，用于处理G信号的模拟变换电路56g和用于处理B信号的模拟变换电路56b。图3A至3F是表示56中各点的视频信号波形图。

如图3B所示，控制信号S6的波形对于“高”电平取峰值即电压H和对“低”电平取另一峰值即电压L和周期地在“高”电平和“低”电平之间交替变化。此信号被送入逻辑电路62，开关SW1、SW2和SW3和用作同步信号。

当在开关SW1、SW2和SW3中控制信号S6处于高电平，所有“C”端同时与各自的“b”端相接，而与各自的“a”端同时断开。另一方面，当控制信号S6处于低电平时，所有“C”端同时与各自“a”端相接，而同时与各自的“b”端断开。

在开关SW1中，

端“a”上加有用可变电阻R1调节的满刻度电压VFS，而端“b”接地。正如前述，端“a”和“b”随着输入端“d”的控制信号S6交替地与端“c”相接。随着交替相接，端“c”产生峰值等于满刻度电压VFS的脉冲，并将此脉冲作为信号S11发送至放大器AMP1的负（一）端。输入放大器AMP1（一）端的信号S11在放大器内被放大（－1）倍，输出图3D所示波形。

在开关SW2中，端“a”上加有用可变电阻R2调节的补偿电压VOF，而端“b”接地。正如前述，端“a”和“b”随着输入至端“d”的控制信号S6交替地与端“c”相接。随着交替相接，端“c”产生峰值等于补偿电压VOF的脉冲，并将脉冲作为信号S16发送至放大器AMP3的正（＋）端。在开关SW3，端“b”上加有用可变电阻R2调节的补偿电压VOF，而端“a”接地。如同前述，端“a”和“b”随着输入至端“d”的控制信号S6交替地与“c”端相接。随着交替相接，端“c”产生峰值等于补偿电压VOF的脉冲，并将脉冲作为信号S17发送至放大器AMP3的负（一）端。因此，这些信号S16和S17互相同步，但逻辑上彼此反相，或更确切地说，当信号S16处于高电平，则信号S17即处于低电平。

放大器AMP3从输入至(＋)端的信号S16减去输入至(－)端的信号S17，将由此合成的信号S13输出至放大器AMP2的(－)端。

数字视频信号S8对已被γ校正电路55r、55g和55b量化并输出的数字视频信号SγR、SγG和SγB中任一信号作出响应。顺便提一下，γ校正电路55r、55g和55b依据图4c所示特性曲线将输入信号变换为输出信号，因此，数字视频信号S8被加给逻辑电路62，信号S8的波形如图3A所示取恒定电压VP为峰值。

逻辑电路62还接收如图3B所示波形的在一个行周期间隔交替反转的信号S6，并在信号S6和数字视频信号S8之间进行逻辑运算，从而将数字视频信号S8变换为如图3AA所示的数字视频信号数据串D0、D1、D2，并被输出至D／A变换器59(此处数字视频信号S8被数字化以表示它原有的和在每一行周期交替反转时的波形成分。

D／A变换器59在其参考电压输入端VREF接收已借助可变电阻R1调节的满刻度电压VFS的输入，并根据该输入，将输入的视频信号数据串D0、D1、D2...变换为对应的模拟信号，从而形成如图3c所示波形以满刻度电压VFS为峰值的视频信号S9。这样产生的信号S9从输出端VOUT输出至放大器AMP1的(＋)端。

放大器AMP1从信号S9中减去信号S11，由此生成的信号作为信号S12输出至放大器AMP2的(＋)端。信号S9有如图3C所示波形，信号S11被放大(－1)倍，取图3D所示波形。因此，信号S12具有由图3C所示波形和图3D所示波形相加形成的图3CC所示波形。

放大器AMP2从信号S12减去信号S13，由此合成的信号作为视频信号S14输出至液晶显示器／光学变换部分57。这视频信号S14与视频信号SR、SG和SB中任一信号相对应。信号S12有图3CC所示波形，和信号S13放大(－1)倍，取图3E所示波形。因此，信号S14具有由图3E所示波形和图3CC所示波形相加形成的图3F所示的波形。

如上所述，对于传统的白平衡调节要杜绝在显示图象上由于各个器件元件的色散引起的图象的色不均匀性是困难的，另一方面，上文提及已公开的日本专利申请昭63No.37785的目的是在所排列的液晶显示屏之间进行校正。因此在图象内任何色不规则性或不均匀性不能被校正。

此外，依照图1所示的结构，显示装置由用于红、绿和兰色（下文分别用R、G和B表示，红、绿和兰三色用RGB表示）具有三个各自电路的三个液晶显示器构成，（每个液晶显示器有一个电路）。因此，三个电路在它们电路常数上包含离散，三个液晶显示器在电压－透射特性上也一定有离散。这种离散引起例如在本应该显示类似黑或白色的非彩色处出现彩色的不良效应。这种不良使得必需要个别调节每个电路的补偿电压VOF和满刻度电压VFS。

在先有技术中，这种调节需要下列步骤。首先，为了要在整个图象屏幕上进行纯白显示，例如输入数据是由象空白帧面的预定投影图象组成的。然后，从所读数据图象光学变换产生的投影输出应该用色度仪58测量。供给液晶显示器的信号幅度和偏压，更明确地说，用于每个显示器的满刻度电压VFS和补偿电压VOF应该用控制满刻度电压VFS的可变电阻R1的变化和控制补偿电压VOF的可变电阻R2的变化对于每一色区加以控制，从而调节诸如黑色和白色的色平衡。

然而，这种步骤需要极其细致的调节，甚至会搞得更差，要区别哪个色区的什么电阻应该和以多大程度调节观测到的色度偏移，这是非常困难的。因此这个方法需要即便是熟练的操作人员也要花费很长时间来调节，在生产中造成困难。

本发明要消除上述问题，因此本发明的一个目的是提供这样一种投影图象显示装置，在这装置中图象屏上色不规性或不匀性是通过根据图象屏上色度分布进行校正而加以消除的，并提供用于该装置的校

正方法。

本发明的另一目的是提供能自动进行色度调节的显示装置和用该装置的系统。

为了达到上述目的，本发明的结构如下:

首先，本发明的投影图象显示装置用于将与视频信号的基色分量相对应的三种光投影到屏上形成图象，它包括:

色度测量装置，用于测量所述屏幕上任意坐标点的色度;

第一运算装置，用于对由色度测量装置测得的该坐标的色度单值地计算每个基色分量的第一校正数据;

存储装置，用于根据已测量色度的点的座标存储第一校正数据;

第二运算装置，按若干坐标点从存储装置读出第一校正数据，根据所读出的第一校正数据计算用于校正地调制要加在发射三基色分量的显示元件上视频信号的第二校正数据，从而形成未进行色度测量的象素；和

校正调制装置，根据由第一和第二运算装置计算的第一和第二校正数据准备用于三基色分量视频校正信号，并用该准备的视频校正信号调制原视频信号。

依据本发明，用于对将对应于视频信号的基色分量的三种光投影到屏幕上形成图象的投影图象显示装置中的色不均匀性进行校正的方法包括以下步骤:

测量屏幕上任意坐标点的色度(第一步) ;

根据在第一步测得的坐标点的色度单值地计算每个基色分量的第一校正数据(第二步) ;

按已测量色度的这些点的坐标将第一校正数据存入存储器装置(第三步) ;

按若干坐标点从存储装置读出第一校正数据，并根据所读出的第

一校正数据计算用于校正调制要加在发射三基色分量的显示单元上视频信号的第二校正数据，从而形成未进行色度测量位置的象素(第四步)；和

根据由第二和第四步计算得到的第一和第二校正数据准备出用于三基色分量的视频校正信号，并用已准备的视频校正信号调制原视频信号(第五步)。

依照本发明的另一方面，投影图象显示装置还包括:

电压变化装置，能分别地改变输出至显示单元的视频信号的幅度电压和偏置电压;

控制装置，输出用于控制电压变化装置的控制信息；和

存储装置，存储从控制装置输出的控制信息。

本发明的还有一个方面在于，投影图象显示装置包括:

投影图象显示单元和色度调节系统，所述投影图象显示单元包括:

电压变化装置，该装置能分别地改变输出至显示单元的视频信号的幅度电压和偏置电压;

第一控制装置，该装置输出第一控制信息用于控制电压变化装置；和

存储装置，该装置存储从第一控制装置输出的第一控制信息，和

所述色度调节系统包括:

色度测量装置，用于测量由投影图象显示单元发出的光输出的色度；和

第二控制装置，该装置输出第二控制信号指示第一控制装置输出第一控制信息，以根据从色度测量装置输出的色度测量值控制电压变化装置。

在依据本发明这样构造的投影图象显示装置中，第一运算装置从

由色度测量装置测量的屏上任何坐标点的色度，单值地计算每个基色分量的校正数据。此后可将这样计算得到的校正数据按已测量色度的点的坐标存入存储装置。因此，重复地读出校正数据供查阅或计算操作时使用是可能的。

第二运算装置可以根据按若干坐标点从存储装置读出的第一校正数据，计算用于校正调制要加在发射三基色分量的显示单元上的视频信号的第二校正数据，以形成未进行色度测量位置的象素。

由第一和第二运算装置计算的第一和第二校正数据是这样构成的，以致当依据这些数据在屏上重现投影图象时，第一和第二校正数据两者都不会相互引起任何色不规则性或不均匀性。因此，通过使校正调制装置从全部校正数据准备出用于三基色分量的视频校正信号，并根据已准备的视频校正信号调制对应于各自三基色的每一原始视频信号。

依据本发明用于校正投影图象显示装置中的色不均匀性的方法，对每一基色分量的第一校正数据是根据在第一步测量的任意坐标点的色度值，在第二步单值地计算出来的。此后在第四步，根据在第二步计算的与若干坐标点联系的第一校正数据，可以执行对用于校正调制要加到发射三基色分量的显示单元上视频信号的第二校正数据的计算，从而形成未进行色度测量的象素。

在第二和四步计算的第一和第二校正数据是这样构成的，以致当依据这些数据在屏上重现投影图象时，第一和第二校正数据两者都不会相互引起任何色不规则性或不均匀性。因此可在第五步通过从全部校正数据准备用于三基色分量的视频校正信号，并根据已准备的视频校正信号调制对应于各自三基色的每一原始视频信号而获得没有色不匀性的投影图象。

而且，在本发明的投影图象显示装置中，电压变化装置能够独立

地改变由显示单元输出的视频信号的幅度电压和偏置电压。此外，控制装置可以输出控制信息用于控制电压变化装置，从而使显示单元能跟随适当的程序改变输出幅度电压和偏置电压，借以获得具有最佳色度的投影图象。此外，借助于可将控制信息保持为非易失性存储的存储装置，使得投影图象的重现能具有最佳色度。

在本发明的投影图象显示装置中色度调节系统的运行可描述如下：

首先，在投影图象显示装置中，电压变化装置能够独立地改变由显示单元输出的视频信号的幅度电压和偏置电压。此外，第一控制装置可以输出第一控制信息用以控制电压变化装置，从而使显示单元能跟随适当的程序改变输出幅度电压和偏置电压，由此获得具有最佳色度的投影图象。而且，借助于能保持控制信息为非易失存储的存储装置，使得投影图象的重现能具有最佳色度。

根据色度测量装置对投影图象显示装置发出的光输出色度的测量，第二控制装置可以输出第二控制信息至第一控制装置，从而指令第一控制装置去输出用于控制电压变化装置的第一控制信息。

图1是表示用于产生为常规液晶显示器所提供的视频信号的电路方块图；

图2是表示图1所示的模拟变换电路的电路图；

图3A是表示在图2所示的模拟变换电路中经过变换产生的投影图象信号的波形图；

图3B是表示在图2所示的模拟变换电路中经过变换所产生的投影图象信号的波形图；

图3AA是表示在图2所示的模拟变换电路中经过变换产生的投影图象信号的波形图；

图3C是表示在图2所示的模拟变换电路中经过变换产生的投影图

象信号的波形图；

图3D是表示在图2所示的模拟变换电路中经过变换产生的投影图象信号的波形图；

图3cc是表示在图2所示的模拟变换电路中经过变换产生的投影图象信号的波形图；

图3E是表示在图2所示的模拟变换电路中经过变换产生的投影图象信号的波形图；

图3F是表示在图2所示的模拟变换电路中经过变换产生的投影图象信号的波形图；

图4A表示在逻辑电路中输入和输出之间关系的图；

图4B是表示在逻辑电路中输入和输出之间关系的图；

图4C是表示在逻辑电路中输入和输出之间关系的图；

图5表示作为本发明的一个实施例在液晶显示屏上色度测量点的位置图；

图6表示在本发明一个实施例中光学装置的位置关系的说明示图；

图7是表示用于图6所示装置中的液晶投影图象显示器的结构的立体图；

图8是本发明一个实施例所使用的电路方块图；

图9是表示在本发明一个实施例中所使用的液晶显示器上位置关系，和已测色度的各点和运用线性插值计算校正数据的各点之间的关系图；

图10是表示构成本发明的另一实施例的电路方块图；

图11是图10所示电路中所使用的模拟变换电路的电路图；

图12A是表示图10所示实施例中光学装置的一种关系的说明示图；

图12B是表示图10所示实施例中光学装置的另一种关系的示意图；

图13A表示在图10所示实施例中对白色进行色度调节时使用的视频信号的波形图；

图13C表示在图10所示实施例中对白色进行色度调节时使用的视频信号的波形图；

图13F表示在图10所示实施例中对白色进行色度调节时使用的视频信号的波形图；

图13B表示在图10所示实施例中对白色进行色度调节时使用的视频信号的波形图；

图14表示液晶显示器的所加电压一透射比的特性曲线图；

图15是在图10所示实施例中对白色进行色度调节时在色度图上所示的控制步骤的说明图；

图16A是表示在图10所示实施例中对白色进行色度调节时对在色度图上各区域所预置的控制步骤和被控制的相应颜色的表格；

图16B是表示在图10所示实施例中对黑色进行色度调节时对在色度图上各区域所预置的控制步骤和被控制的相应颜色的表格；

图17A表示在图10所示实施例中对黑色进行色度调节时使用的视频信号的波形图；

图17C表示在图10所示实施例中对黑色进行色度调节时使用的视频信号的波形图；

图17F表示在图10所示实施例中对黑色进行色度调节时所使用的视频信号的波形图；

图17B表示在图10所示实施例中对黑色进行色度调节时所使用的视频信号的波形图；

图18是在图10所示实施例中对黑色进行色度调节时在色度图上所示的控制步骤的说明图；

首先，图5表示作为本发明的一个实施例所示的液晶显示屏上色

度测量点的例子，而图6是在此测量中所使用元件的位置关系的示意图。在作此测量时最好在使液晶有尽可能大的透射比的情况下来进行液晶显示器中色散的校正。因此，下列色度校正的操作是使用“白色”投影图象来进行测量光输出，从而决定显示图象屏上的色度分布。

在图6中标为33的是依照本发明一个实施例的液晶投影图象显示装置的元件矩阵，这个元件矩阵33具有如图7所示的结构。图7所示的该结构包括滤色片40、液晶42、二极管44、象素电极45、一对极化板47和50和一对玻璃衬板48和49。这里标号43和46分别标注从光源32发出的白光线和扫描线。众所周知，一个元件位于一个象素电极所占的面积，并用作提供三基色RGB中的一种颜色。从三个不同元件发射的每束表示RGB三色之一色三个RGB彩色光束，会聚在屏1上认作一个象素。RGB三色中每色的亮度通过改变加到每个象素电极45上的电压，从而改变液晶的透射比，借此控制透过液晶的光强来加以控制的。

图6中标号34标注由透镜和镜子等组成的光学系统，用于将RGB光会聚在屏1上。更确切地说，从光源32发出的透过液晶投影图象显示元件矩阵33的白光中有若干光束组，这些光束组是这样构成的，即，每个光束组有RGB光分量和在光强上受到调节，以产生一个象素。包含RGB分量的这样构成的光束组透过光学系统34会聚在屏1上，以在屏上形成图象。这样形成的图象由用户可从观看方向35看到。

色度仪36的未图示的传感器部分位于屏1上诸象素的位置，用于色度测量。色度仪36测量待测象素的色度。并将每个象素的色度测量数据通过色度数据信号路径38输出至液晶投影图象显示元件矩阵控制部分37。应注意色度数据信号路径38可以不仅由有线装置构成，而且也可由使用例如红外载波信号等无线装置构成。

下面参阅图5，已经透过液晶投影图象显示元件矩阵33的由RGB光分量组成的光束组投影在屏1上，从而形成由视频信号所特定的呈现

一定色彩的象素a2。一系列这样的象素a2在水平和垂直二个方向上紧密排列从而形成一幅图象。这样用户就把屏1上排列的象素a2组合看成一幅图象。在这成象过程中，产生象素a2的投影图象的液晶投影图象显示元件矩阵33起着关键作用，但是要制造在所有象素中完全没有输出光强变化的液晶投影图象显示元件矩阵33是不可能的。换句话说，可以予料液晶投影图象显示元件矩阵33的每个象素在输出光强上多少与其他部分象素会有些不同。在输出光强上的这种不同引起象素a2在色度上的不同，造成色不均匀性。因此，对校正色不均匀性的控制过程可按下列方式进行。首先，从象素a2组成的每个微区等同地选择象素2，对这样选择的象素2测量其色度。该测量值被反馈至加在分别形成RGB三色的三个液晶投影图象显示器上的视频信号中。通过这一反馈，校正用于产生其余未被选择的象素a2的视频信号，使得光输出可以被增大或减小，从而消除象素a2中的色度差异。

在选择被测量的象素2时，形成以一定间隔排列的水平线3和以一定间隔排列的垂直线4，位于这些线之间的交叉点，即格点的象素可从被选择为要测量色度的象素2。色度仪36这样构造，使得色度仪元件位于这样选择的每个象素2处并测量色度。此处，测量色度的象素2将用坐标点(U、W)表示，每个色度测量值按其坐标点(U、W)被存储，并将用于计算操作。

为了依据色度测量的反馈，产生其余未被选择的象素a2，下面说明加到分别形成RGB三色的三个液晶投影图象显示器上视频信号的校正方法。首先，根据对每个象素2测得的色度值计算该点的RGB每色的校正数据。然后，采用依据包围象素a2的最近四个网格点的RGB每色的校正数据进行线性插值近似法，计算未测量色度的象素a2的RGB每色的校正数据。

其次，说明根据在象素2测得的色度数据决定被测量象素2的G、B

R信号中每个的校正数据的计算方法。

例如，倘若在屏1上用坐标(U、W)标明象素2，提供色度测量数据(X、Y)，则校正数据<G>、<B>和<R>可以由下列表达式单值确定:

$$<G>=aX+by \qquad \ldots(1)$$

$$<B>=CX+dy \qquad \ldots(2)$$

$$<R>=ex+fy \qquad \ldots(3)$$

式中a、b、c、d、e和f均为常数。

这里应注意上面提及的所有校正数据<G>、<B>和<R>也可由该装置外面的计算装置来决定。

图8表示在本发明的第一实施例中使用的电路方块图。结合图8将详细说明根据如上获得的<G>、<B>和<R>反馈校正数据决定形成图9所示象素a2g的RGB三色校正数据的计算过程。这样决定的RGB三色校正数据用于校正分别加到用于分别显示RGB三色从而构成象素a2g的三个液晶投影图象显示单元的三个视频信号。

校正数据写入电路5拾取色度仪36对屏1上坐标(U、W)处的象素2的色度测量值(X、Y)，并根据方程(1)、(2)和(3)计算校正数据<G>、<B>和<R>，将结果存入各自校准数据存储器7、8和9中。同时，校正数据写入电路5产生对应于屏上象素2的坐标(U、W)的地址信息AD{(U、W)}，以将该地址信息与算得的校正数据<G>、<B>和<R>一起输出至校正数据存储器7、8和9。

校正数据存储区28由校正数据存储器7、8和9组成，并从校正数据写入电路5接收地址AD{(U、W)}，每个地址指定相应的校正数据存

储器7、8或9中的一个地址。校正数据存储区28也从相同的校正数据写入电路5获得对每一色度值的校正数据<G>、<B>和<R>，并将这些色度数据贮存在上述指定的地址AD{(U、W)}。

存储地址产生电路6根据通过端19、20和21输入的用于显示的视频信号所用的同步信号H、V和时钟信号CK，识别接着要被重现为投影图象象素的象素a2的坐标(U、W)。

现在作为例子考虑这一情况：电路6识别存在于图9所示坐标点(Ug、Wg)的象素a2g期望接着要被再现。在此情况下，为了产生象素a2g必须要决定用于校正调制要加到分别用于显示RGB三色的各自三个液晶投影图象显示单元中液晶上的原视频信号SEg、SEb和SEr的校正信号Sg、Sb和Sr。为了计算信号Sg、Sb和Sr，需要包围点(Ug、Wg)的四个邻近象素2a(Ua、Wa)、2b(Ub、Wb)、2C(Uc、Wc)和2d(Ud、Wd)上的校正数据，因此存储地址发生电路6在校正数据存储区28产生地址AD{(Ua、Wa)}、AD{(Ub、Wb)}、AD{(Uc、Wc)}和AD{(Ud、Wd)}，在这些地址上存储相邻四个象素2a、2b、2c和2d的校正数据<G>、<B>和<R>。这样产生的地址被输出至校正数据存储区28，因此下列关系成立：

$$Ua = Uc < Ug < Ub = Ud \quad \ldots(4)$$

$$Wa = Wc > Wg > Wb = Wd \quad \ldots(5)$$

校正数据插值处理电路10，11，12通过按下述方法使用包围象素a2g的四个象素2的校正数据<G>、<B>和<R>执行线性插值运算，分别计算象素a2g的校正数据<G>、<B>和<R>，并将结果分别输出至D／A变换器13、14和15。

作为例子，说明对G信号校正数据的线性插值过程的计算。用于G信号校正数据的校正数据存储器7对于象素2a(Ua、Wa)、2b(Ub、Wb)、2c(Uc、Wc)和2d(Ud、Wd)在地址AD{(Ua、Wa)}、AD{(Ub、Wb)}、AD{(Uc、Wc)}和AD{(Ud、Wd)}分别保持有校正数据<Ga>、<Gb>、<Gc>和<Gd>。当存储地址发生电路6输入这些地址AD{(Ua、Wa)}、AD{(Ub、Wb)}、AD{(Uc、Wc)}和AD{(Ud、Wd)}时，存储器7依次将校正数据<Ga>、<Gb>、<Gc>和<Gd>输出至G信号的校正数据插值处理电路10。

因为关系式(4)和(5)对屏1成立，可以假定象素2b和2d分别位于象素2a和2c的向右第K个位置。假定象素2c和2d分别位于象素2a和2b的下方第n个位置。而且，对图9中每点的G信号的校正数据将假定如下:

<Ge>: 位于象素2a下方第m个位置的标有坐标(Ue、We)的象素a2e的G信号校正数据;

<Gf>: 位于象素2b下方第m个位置的标有坐标(Uf、Wf)的象素a2f的G信号校正数据;

<Gg>: 位于象素a2e的向左第J个位置的标有坐标(Ug、Wg)的象素a2g的G信号校正数据;

在这种假定下，<Ge>、<Gf>、和<Gg>由下列表达式给定:

$$\langle Ge\rangle = \{(\langle Ga\rangle - \langle Gc\rangle)/n\} \times m + \langle Ga\rangle \qquad \cdots (6)$$

$$\langle Gf\rangle = \{(\langle Gb\rangle - \langle Gd\rangle)/n\} \times m + \langle Gd\rangle \qquad \cdots (7)$$

$$\langle Gg\rangle = \{(\langle Gf\rangle - \langle Ge\rangle)/k\} \times j + \langle Ge\rangle \qquad \cdots (8)$$

式中下列关系成立:

$$Ua = Uc = Ue,\ Ub = Ud = Uf;$$
$$Ua + j = Ug,\ Ua + k = Ub;$$
$$Wa = Wb,\ Wc = Wd,\ We = Wf = Wg;\ \text{and}$$
$$Wa = Wc + n = We + m.$$

校正数据插值处理电路(用于G信号)10根据公式(6)、(7)和(8),分别计算在点(Ue、We)、(Uf、Wf)和(Ug、Wg)存在的象素a2e、a2f和a2g的色度值校正用的G信号校正数据<Ge>、<Gf>和<Gg>,并将结果输出至D/A变换器13。对于已进行色度测量的象素2就无需用线性插值法计算校正数据<G>。因此,存储在较正数据存储区28的校正数据就可以按现状使用。

使用相同的线性插值法可计算B信号和R信号的校正数据<B>和<R>。

D/A变换区30由D/A变换器13、14和15组成,它们接收作为数字数据的象素2和a2的校正数据<G>、<B>和<R>,将这些数据转变为具有模拟值校正信号Sg、Sb和Sr,并将结果分别送至放大器16、17和18。

在校正调制部分31,放大器16通过端22接收用于显示G色待加到液晶投影图象显示器上的原视频信号SEg。以同样方式,放大器17通过端23接收用于显示B色待加到液晶投影图象显示器上的原视频信号

SEb，而放大器18通过端24接收用于显示R色待加到液晶投影图象显示器上的原视频信号SEr。这些信号被依据来自D／A变换部分30的校正信号Sg、Sb和Sr在放大幅度上受到校正调制，所形成的视频信号SLg、SLb和SLr从端25、26和27输出被加到液晶投影显示器的各个液晶单元上，形成GBR三色。

如上所述，用于再现投影图象的象素的色度被逐次校正，因此可以消除在整个图象上的色散。

图10表示实施本发明另一实施例的电路方块图。在此图中，γ校正电路55r、55g和55b是完全相同的（因此，总称为γ校正电路55），模拟电路56r、56g和56b都是由图11所示的相同模拟变换电路56组成的。至于视频信号的流程，和图1和2所述相同的信号流将用相同标号标出，有关的说明均予略去。

图12A和12B表示在该实施例中所使用元件的光学结构的关系。由于每个元件与图6中有相同功能，故标以相同标号而省去其有关说明。如图所示，可认为有两种光学结构。图12A所示情况是这样安排，透过透明屏1的图象被色度仪36感测或被用户从观看位置35看到。图12B所示另一情况是这样安排，使得借助光学系统34在屏1上形成的图象被色度仪36感测或被用户从观看位置35看到。

参阅图10和11，将说明对白色进行色度调节的步骤。在图13A、13B、13C和13F中画出所出现的视频信号波形。在图4A至4C中画出逻辑电路62中输入信号S8和输出数字视频信号数据D0、D1、D2....。微计算机51输出控制信号S3至系统微计算机52，系统微机又根据从微机51接收的控制信号S3，依次输出由图13B所示波形表示的信号S6至逻辑电路62，开关SW1、Sw2和Sw3。

γ校正电路55的γ校正变换表（未图示）由随机存取存储器（下文称为“RAM”）构成，因此便于系统微计算机52重写该表。这表容

许数字视频信号数据D0、D1、D2...被建立，以表示图13A所示具有常数数据值FFH的波形，而与图4A所示输入的数字视频信号S8的幅度多大无关。这种结构不再需要专门单独的信号发生器。当然，通过例如使用能控制系统的信号发生器提供的其他装置，可以容许等同的结构。

D／A变换器60根据从输入端VREF输入的作为基准电压的偏置电压而改变满刻度电压VFS，依照来自系统微计算机52在输入端CTRL输入的控制信号S7的指令输出取满刻度电压VFS为其电平的信号S10。这样形成的输出信号S10被送往开关SW1的a端。以同样方式，D／A变换器61根据通过输入端VREF输入的作为基准电压的偏压而改变补偿电压VOF，并依照来自系统微计算机52在输入端CTRL输入的控制信号S7的指令输出取补偿电压VOF为其电平的信号S15。此输出信号S15被送往开关SW2的a端和开关SW3的b端。

与此同时，D／A变换器59接收数字视频信号S8和控制信号S6以及接收通过输入端VREF输入作为基准电压始终保持在满刻度电压VFS波形的信号S10，输出如图13c所示波形的视频信号S9，信号S9波形是由图13A和图13B所示波形在放大器AMP1的(＋)端上相加而成的。因此，模拟变换器56将输出如图13F所示波形或幅度等于补偿电压VOF而基准电压为0V的脉冲波形的视频信号S14，而与满刻度电压VFS无关。

在控制决定视频信号S14幅度的补偿电压VOF时，系统微计算机52接收从微计算机51输出的控制信号S3，并根据此信号输出控制信号S7至每个模拟变换器56中存在的D／A变换器61的CTRL端，从而改变从D／A变换器61的VOUT端输出的补偿电压VOF的幅度。在此期间，当控制信号S7也加在D／A变换器60的CTRL端时，该系统必须设计为仅仅改变D／A变换器61输出的补偿电压VOF，而不改变从D／A变换器60的VOUT端输出的满刻度电压VFS。这种控制方法例如已在IEEE-STD-488中公

开。

图14表示调节白色色度用的液晶上所加电压与其透射比之间的关系图。在该图上横坐标轴表示所加电压。纵坐标轴表示液晶透射比。特别是，当所加电压在VW0、VW1、VW2、VW3、VB3、VB2、VB1和VB0时，透射比分别为TW0、TW1、TW2、TW3、TB3、TB2、TB1和TB0。

当通过操作模拟变换电路56，控制幅度等于加在液晶上视频信号S14的补偿电压VOF使其降低至VW3时，液晶的透射比变得足够高，以提供来自液晶显示器/光学变换部分57的已增大光输出RAY。反之，从图14可理解，当所加电压取VW3周围的值时，透射比随所加电压的改变而有相当大的变化，以致难于产生灰度等级因此当通过γ校正调节透射比时，液晶透射比的量化引起的误差倾向于变大。

另一方面，假如所加电压稍为高些，使得补偿电压VOF可以等于VW0，则由图14可理解在电压VW0附近透射比随所加电压改变的变化很小，因此易于产生灰度等级，但是液晶显示器/光学变换部分57的光输出RAY太小，造成对比度很差。

对提供易于产生灰度等级和适当的亮度和对比度的最佳电压的调节已通过试验实现，但这实施例把该调节留给微计算机51去完成。更确切地说，微计算机51输出用于控制产生灰度等级程序的控制信号83，而系统微计算机52根据控制信号S3输出控制信号S7至模拟变换电路56。模拟变换电路56根据控制信号S7，在从VW1至VW3的范围内改变表示液晶上所加电压的视频信号S14，以使液晶的透射比可以在TW1和TW3之间优选。这样选择的最佳值被输出。该控制以同样方式对RGB三色中每色独立地实施，从而选择所有三色均提供最好对比度和灰度等级的状态。

图15是色度图，结合此图说明实施色度调节的程序。首先定义为“白色”的目标色度点假定在色度图上用坐标(Styp1、Ytyp2) 表示

。色度仪58测量未经调节的光输出RAY的色度，并将测量值作为数据信号S2输出至微计算机51。这样获得的色度假定在色度图上用(X、Y) 表示。这点(X、Y) 必定属于1) 、2) 和3) 区中任一区。为了处理任何可能的测量的色度，预先对每区已决定一系列处理程序，并在微计算机51中已编制用于控制运行的程序软件。

假定测量色度点(X、Y) 位于1) 区， 这状态由微计算机51按下列表达式识别:

$$X > X_{typ1}\text{，和}Y > Y_{typ1} \qquad \ldots(9)$$

假定测量色度点(X、Y) 位于2) 区，这状态由微计算机51按下列表达式识别:

$$X < X_{typ1}\text{，和}Y > X \qquad \ldots(10)$$

或者，假定测量色度点(X、Y) 位于3) 区，这状态由微计算机51按下列表达式识别:

$$X > Y, \qquad \text{和}Y < Y_{typ1} \qquad \ldots(11)$$

图16A是表示当要调节“白色”色度时待预置的控制程序和对色度图上各区尚待控制的相应色的表格。

作为一例，假如点(X、Y) 满足条件(9) ，被微计算机51识别，则图16A中对于1) 区这行的步骤1指令执行G色调节。因此，为了使$Y(>Y_{typ1})$ 接近Y_{typ1}，必须减少光输出RAY中的G分量，即液晶上所加电压要取大值，从而增大视频信号S14的幅度。为了达到这一目

的，微计算机51向系统微机52发送信号S3，以增大的G分量的模拟变换电路56g中的补偿电压VOF，从而增大上述S14幅度。系统微机52接收信号S3，向模拟变换电路56g发出信号S7，因而同时增大待输出作为D／A变换器61的输出电压VOUT的补偿电压VOF。

通过上述控制操作，随着光输出RAY的G分量变小，色度仪58检测到色度的Y坐标在减小。微机51通过输出信号S2识别这信息。上述一系列程序将被重复，直至色度测量的Y值与定义为“白色”的点（X_{typ1}、Y_{typ1}）的Y_{typ1}相一致时为止。

下面，再阅图16A，对区1）这行的步骤2规定要执行对R色的调节。因此，为了使X（$>X_{typ1}$）接近X_{typ1}，光输出RAY中的R分量必须被减小，即液晶上所加电压要取大值，为达此目的，微机51向系统微机52发送信号S3，以增大R分量的模拟变换电路56r中的补偿电压VOF。然后，进行与上面对光输出RAY的G分量所执行的相同控制程序，重复这一系列程序直至色度测量的X值与定义为“白色”的点（X_{typ1}、Y_{typ1}）的X_{typ1}相一致为止。

假如在控制操作过程中中间修正点到达其他色度区，则将按预先为该区所设定的程序进行控制。

阅图10和11，说明对黑色调节色度的程序。此处出现的视频信号波形示在图17A、17B、17C和17F中。系统微机52根据从微机51接收到的控制信号S3，将由图17B所示波形表示的信号S6输出至逻辑电路62、开关SW1、SW2和SW3。

由RAM构成的γ校正电路55的γ校正变换表容许数字视频信号数据D0、D1、D2......被建立，以表示如图17B所示具有恒定数据值00H的波形，而与图4B中所示输入的数字视频信号S8的幅度无关。

D／A变换器59接收数字视频信号S8和控制信号S6，以及通过输入端VREF接收作为基准电压具有总是保持在满刻度电压VFS的波形的信

号S10，输出如图17C所示波形的视频信号S9，信号S9是由图17A和图17B所示波形在放大器AMP1（+）端相加而成的。因此模拟变换器56输出的视频信号S14具有如图17F所示波形或幅度等于补偿电压VOF和满刻度电压VFS之和而基准电压为0V的脉冲波形。由于当调节白色色度时，补偿电压VOF已被确定，它不能被改变。因此，视频信号14的幅度，即VOF和VFS之和取决于满刻度电压VFS。

在控制满刻度电压VFS时，系统微机52接收从微机51输出的控制信号S3，并根据这信号输出控制信号S7至存在于每个模拟变换器56中的D／A变换器60的CTRL端，从而改变从D／A变换器60的VOUT端输出的满刻度电压VFS的幅度。在此期间，当控制信号S7也加到D／A变换器61的CTRL端时，该系统设计为仅仅改变来自D／A变换器60的输出满刻度电压VFS，而不改变从D／A变换器61的VOUT端输出的补偿电压VOF。

接着，结合图14说明对黑色的色度调节，图14画出供色度调节用的液晶上所加电压和透射比之间的关系。

当补偿电压VOF和满刻度电压VFS之和，即为加在液晶上的视频信号S14的幅度被控制高达VB3时，液晶的透射比变得足够低，足以使液晶显示器／光学变换部分57提供减小的光输出RAY。反之如从图14可理解的，当所加电压取VB3周围的值时，透射比随着所加电压改变而有相当大的变化，因此难于产生灰度等级，所以当通过γ校正调节透射比时由于液晶透射比量化引起的误差会变得很大。

另一方面，假如所加电压稍为高些，使得补偿电压VOF和满刻度电压VFS之和可以等于VBO，则正如从图14可理解的，在电压VBO附近透射比随所加电压变化而变化很小，因此易于产生灰度等级，但液晶显示器／光学变换部分57的光输出RAY太大，造成对比度极差。

这一调节也留给了微机51去完成。更确切地说，模拟变换电路56根据控制信号S7，在从VB1至VB3的范围内改变表示液晶上所加电压的

视频信号S14，使得可以在TB1和TB3之间优选液晶的透射比。这样选择的优选值被输出。以同样方式对RGB三色的每色独立地实施这一控制，从而选择所有三色都提供最好对比度和灰度的状态。

图18表示色度图。下面结合该图说明实施色度调节的程序。首先，定义为“黑色”的目标色度点假定在色度图上用坐标(X_{typ2}、Y_{typ2}) 表示。色度仪58测量未被调节的光输出RAY的色度，并将测量值作为数据信号S2输出至微机51。这样获得的色度假定由色度图上的(X、Y) 表示。这点(X、Y) 一定属于4)、5) 和6) 区中任一区。为了处理任何可能的色度测量值一系列处理程序是预先已对每区确定了的并在微机51中已编好了用于控制该操作的程序软件。

假定已测色度点(X、Y) 位于4) 区，微机51按下列表达式加以识别这一状态。

$$X < X_{typ2}, \quad 和 Y < Y_{typ2} \qquad \ldots(12)$$

假定已测色度点(X、Y) 位于5) 区，微机51按下列表达式识别这一状态。

$$X < Y \quad , \quad 和 X > Y_{typ2} \qquad \ldots(13)$$

另一可选方案是，假定已测色度点(X,Y) 位于6) 区，微机51按下列表达式识别这一状态。

$$x > Y, \quad 和 Y > X_{typ2} \qquad \ldots(14)$$

图16B是表示当对“黑色”调节色度时，待预置的控制程序和对

于色度图上各区尚待控制的相应色的表格。

作为一个例子，假如点(X, Y) 满足条件(12)，被微机51识别，图16B中对于4) 区这行的步骤1指令执行G色的调节。因此，为了使Y($<Y_{typ2}$) 接近Y_{typ2}，必须增大光输出RAY中G分量，即液晶上所加电压要小，从而要减小视频信号S14幅度。为达此目的，微机51向系统微机52发送信号S3，以增大G分量模拟变换电路56g中的补偿电压VOF，从而减小上述的幅度。系统微机52接收信号S3后，向模拟变换电路56g发出信号S7，从而同时减小作为D／A变换器61的输出电压VOUT输出的补偿电压VOF。

通过上述控制操作，当光输出RAY中G分量变大时，色度仪58检测到色度的Y坐标值增大。微机51通过输出信号S2识别这一信息。以上的一系列程序将被重复，直至色度测量的Y值与定义为“黑色”的点(X_{typ2}、Y_{typ2}) 的Y_{typ2}相一致。

下面再阅图16B，对4) 区这行步骤2规定执行R色的调节，因此为了使X($<X_{typ2}$) 接近X_{typ2}，光输出RAY中的R分量必须增大，即要使液晶所加电压变小。为达此目的，微机51向系统微机52发出信号S3，以减小R分量的模拟变换电路56r的补偿电压VOF。然后，进行与上面对光输出RAY中G分量所执行的相同控制程序，这程序系列将被重复，直至色度测量值的x值与定义为“黑色”的点(X_{typ2}、Y_{typ2}) 的X_{typ2}相一致。关于这一点，假如在控制操作的过程中中间修正点到达其他色度区，则将按预先为该区设立的程序进行该控制。

当上述控制已被完成时，51向52发出控制信号S3，这信号指示表示对每一色的各个优选补偿电压VOF和满刻度电压VFS的控制信号S7的值应该被存储，从而可在任何时间重现这些值。52依照输入的控制信号S3，输出带有控制信号S7的值的信息的数据信号S5至非易失性存储器53，从而将数据存入其中。此后，这样存储的电压值被保持而不会

消失，需要时作为数据信号S4被读出，以重现优选的补偿电压VOF和满刻度电压VFS。

控制信号S3从51至52的传输不仅可用有线装置执行，也可（例如）使用红外载波信号等无线装置来实现。

由于典型投影装置包括作为标准设备的52，对于本发明的控制只要使用软件和需要在内部装入一些特定部件即已足够。

此外，通过提供足以有效履行51功能的52，可以省去51。在这结构中，由色度仪58对光输出RAY色度测量值可以直接被52接收，因此可能实现成本低而工作更迅速的系统。

尽管上述已对使用液晶显示器的一个实施例进行了说明，这应该仅仅看作一个例子，而本发明也可应用于除液晶显示器外的例如CRT等其他显示器件。

依照本发明，三基色中每一色的校正数据是通过线性插值技术用公式计算的，使得根据校准数据重现的投影图象在由显示单元所形成的相邻象素之间呈现很小的色度差。因此，当整个校正数据用于准备具有相对于每一基色模拟值的视频校正信号和具有相对于每一基色模拟值的原始视频信号根据所获得的视频校正信号受到调制时，可能防止本会由于显示单元的分散引起的显示屏上色散分布，因此有可能获得没有色不均匀性的投影图象。

此外，依照本发明，可以显著减少操作人员为色度调节所需要的操作还可能确保迅速完成色度调节，而与操作人员的技能无关。

由于几乎不需要增加例如电路和连线的外部设备，成本也几乎没有增加。

由于投影图象显示装置保持在制造时所调节的优选色度，即使用户对该装置使用不当，也不存在被调好的色度会变得不准而无法恢复的风险。因此，可建立起该装置大大提高了的可靠性。

图 1　先有技术

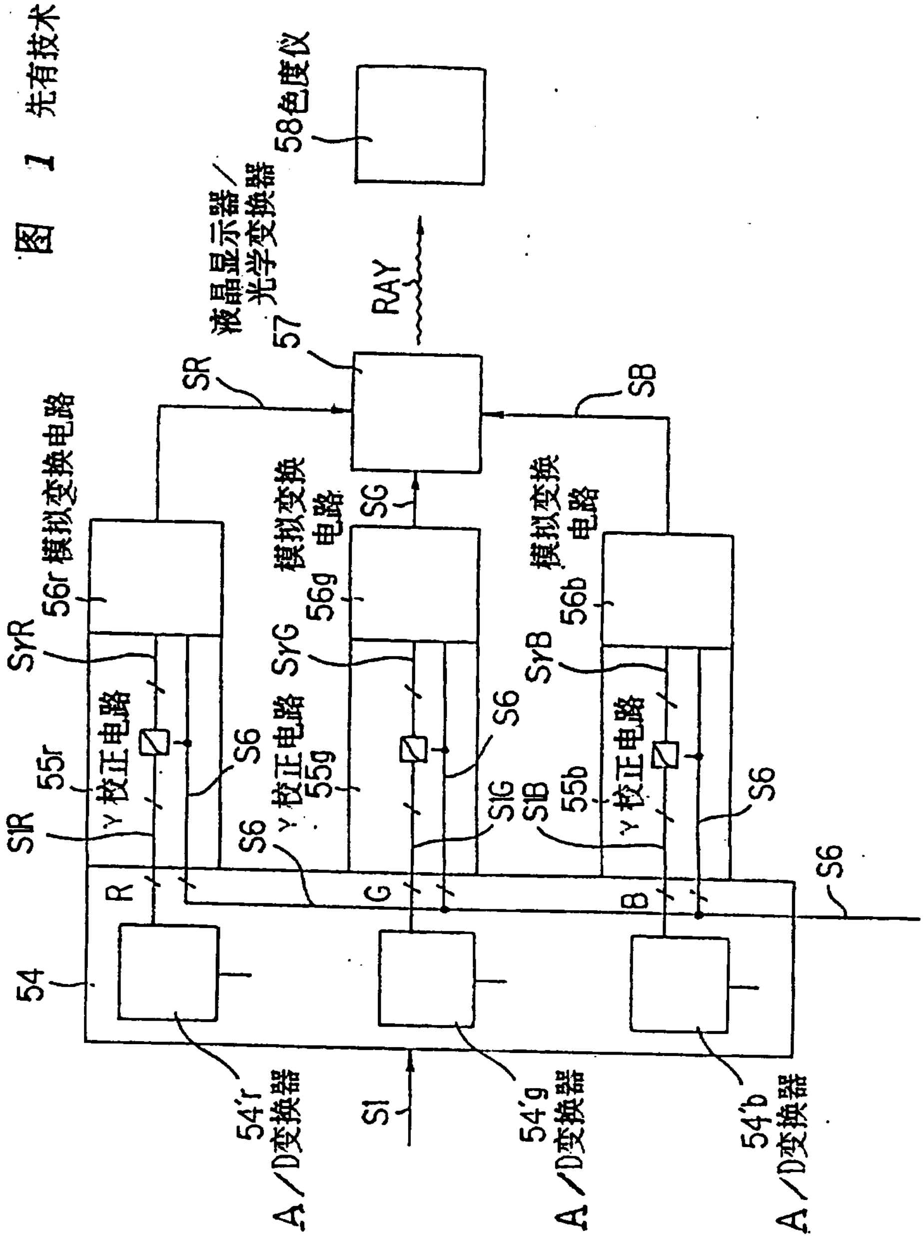
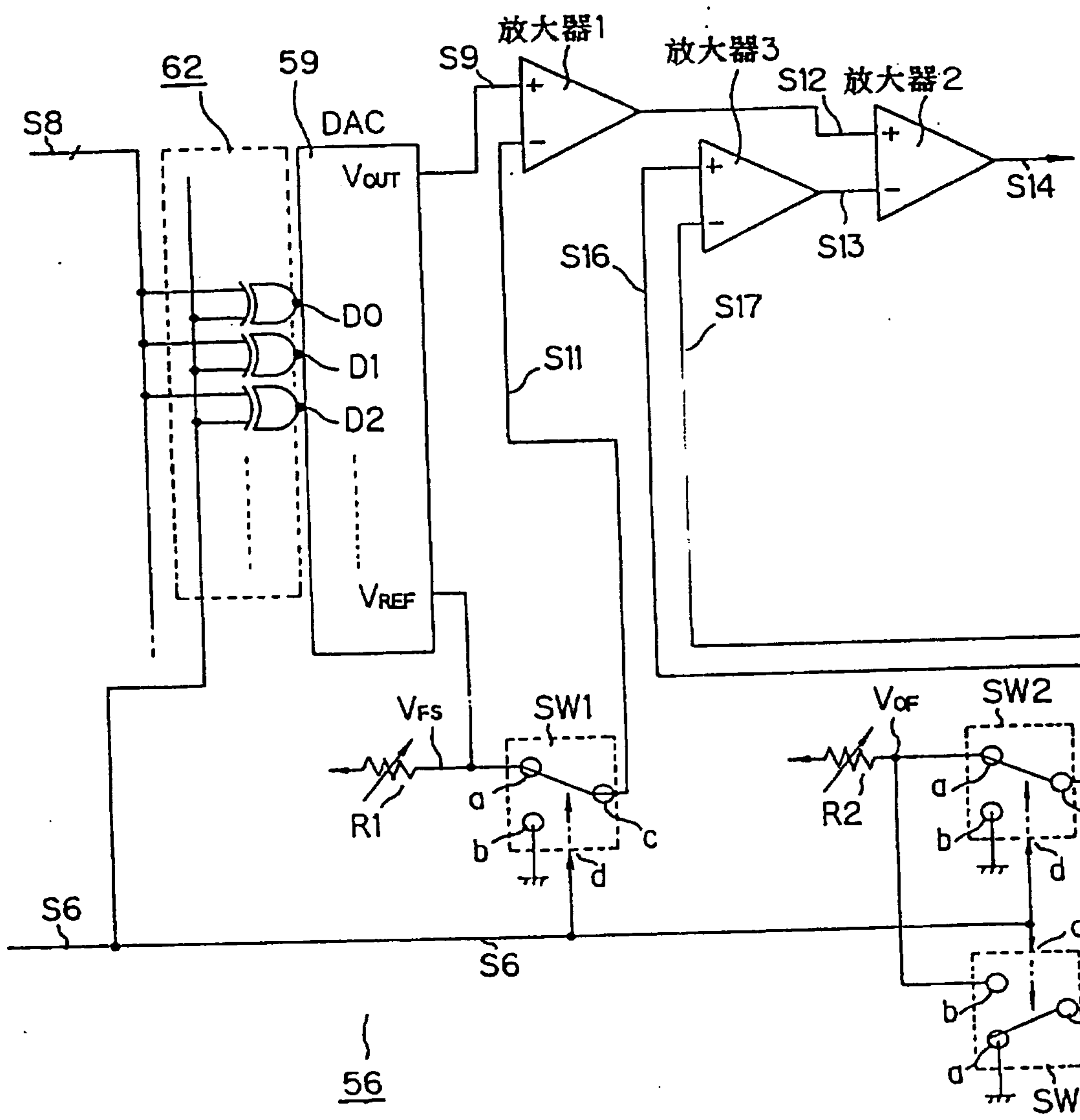

58色度仪
液晶显示器／光学变换器
57
RAY
SR
SB
SG
56r 模拟变换电路
模拟变换电路
56g
模拟变换电路
56b
SyR
SyG
SyB
55r
γ校正电路
γ校正电路
55g
γ校正电路
55b
S6
S1R
S1G
S1B
R
G
B
54
S1
54'r
A／D变换器
54'g
A／D变换器
54'b
A／D变换器

图 2 先有技术



62
59
DAC
S8
VOUT
VREF
D0
D1
D2
S9
放大器1
放大器3
放大器2
S12
S13
S14
S16
S17
S11
VFS
SW1
R1
a
b
c
d
VOF
SW2
R2
SW3
S6
56

图 3A 先有技术

图 3B 先有技术

图 3AA 先有技术

图 3C 先有技术

图 3D 先有技术

图 3CC 先有技术

图 3E 先有技术

图 3F 先有技术

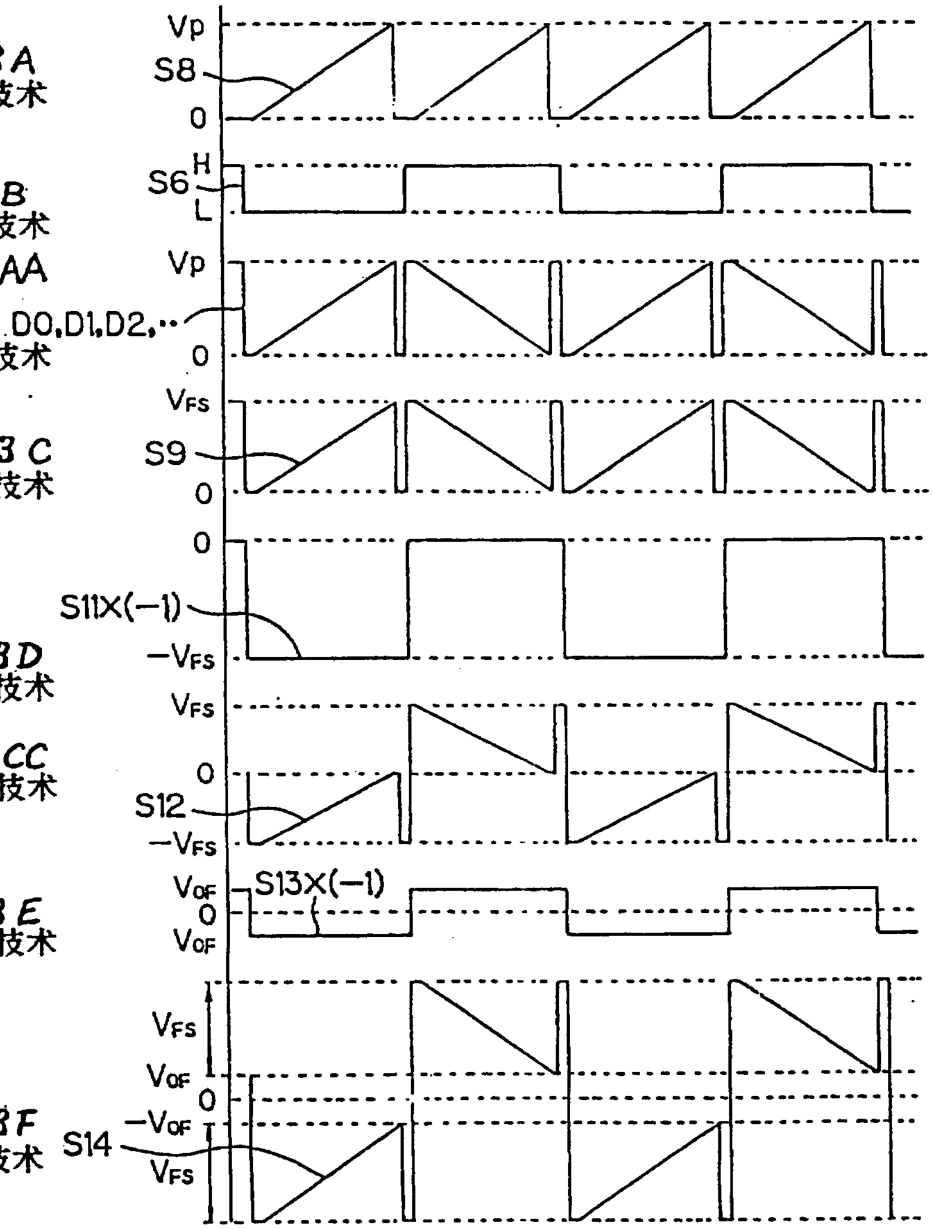


图 4A

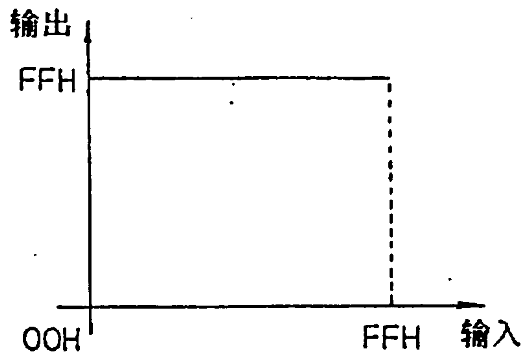


图 4B

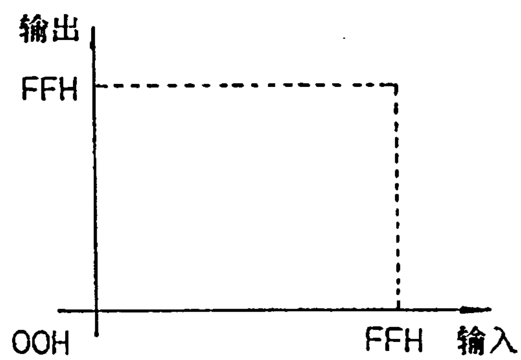


图 4C

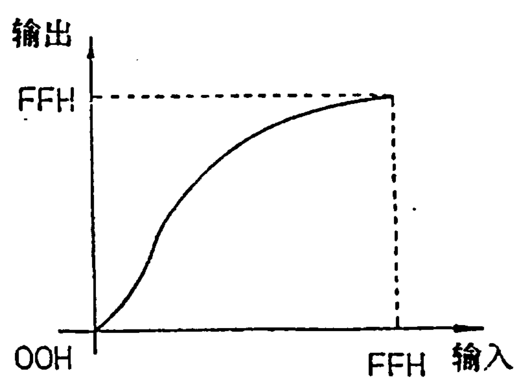


图 5

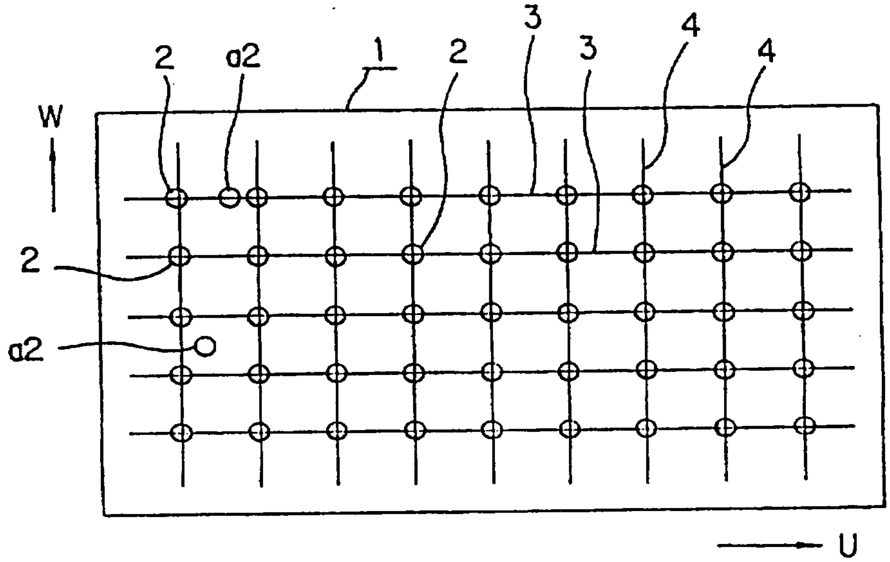


图 6

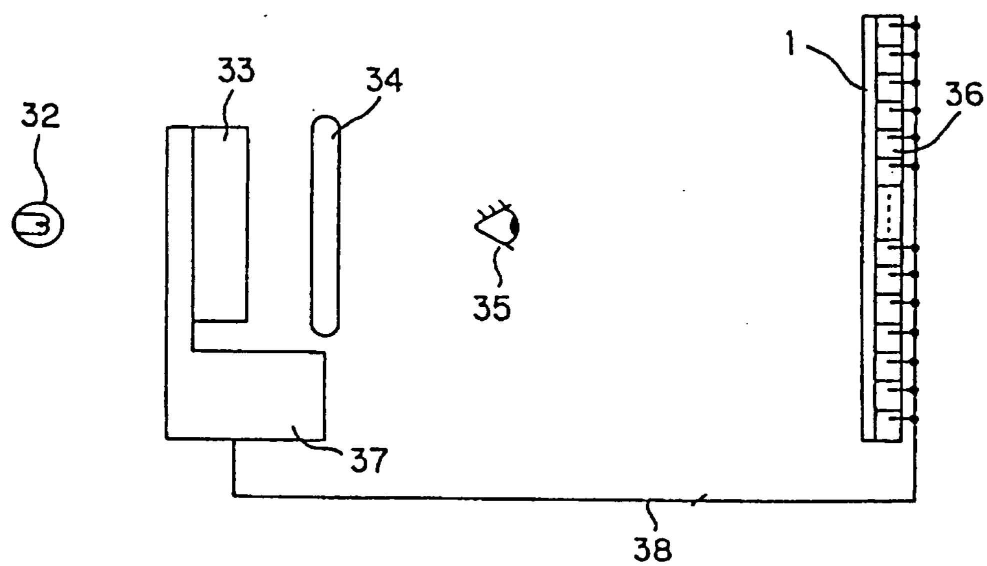


图 7

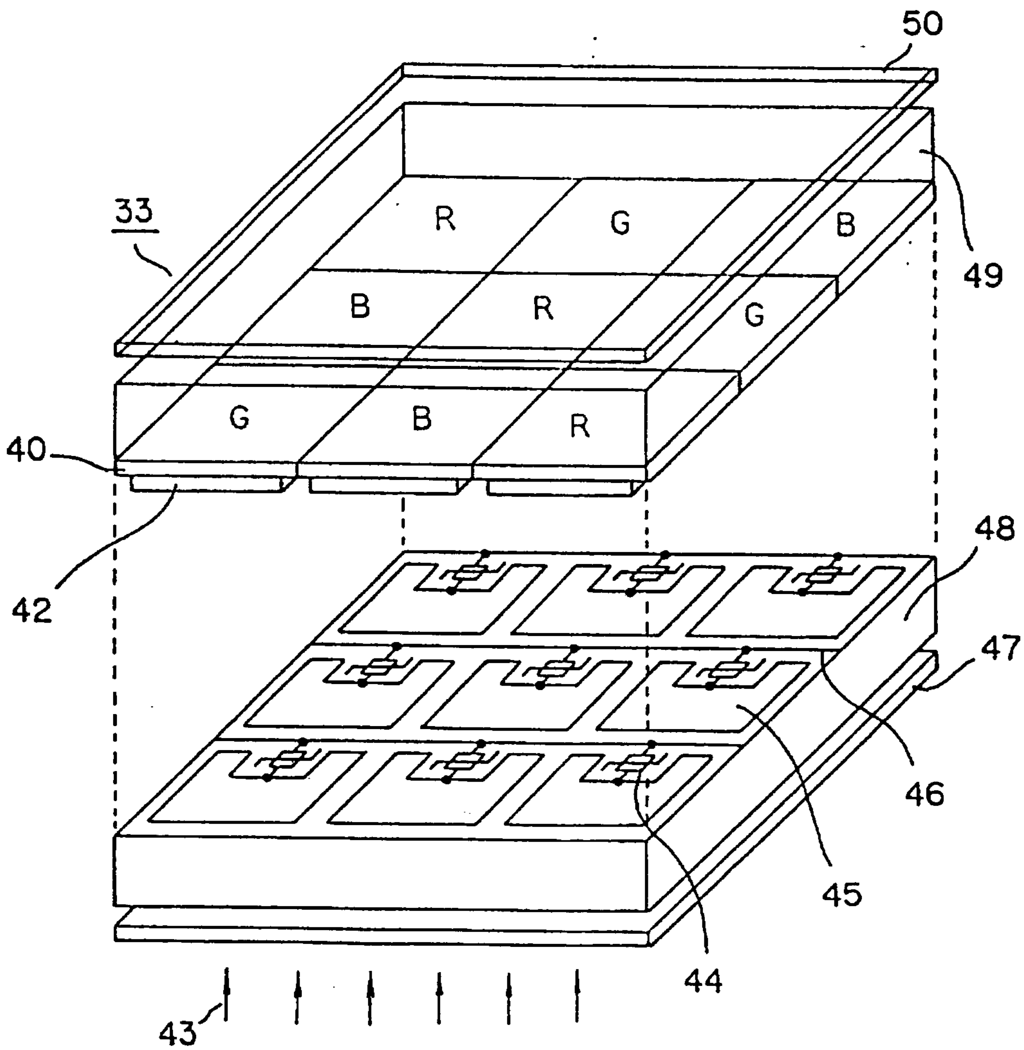
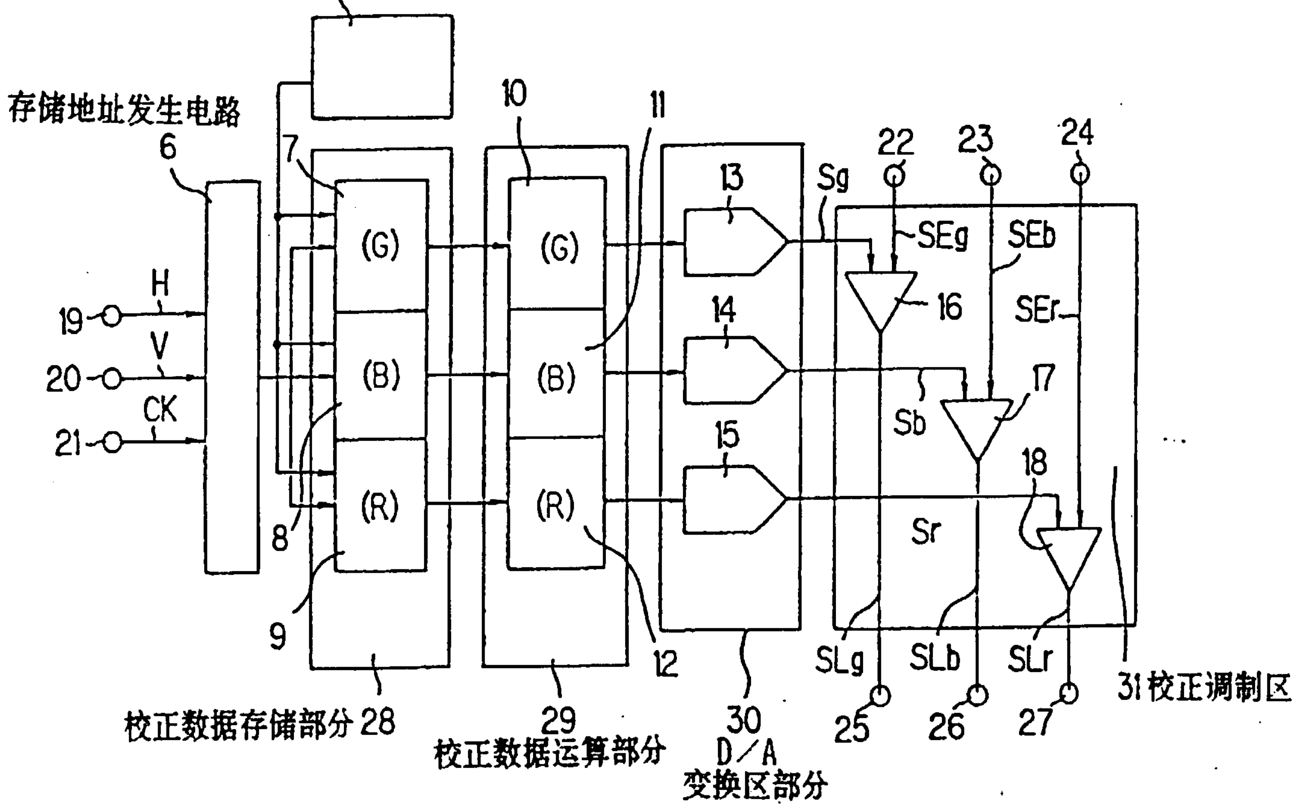
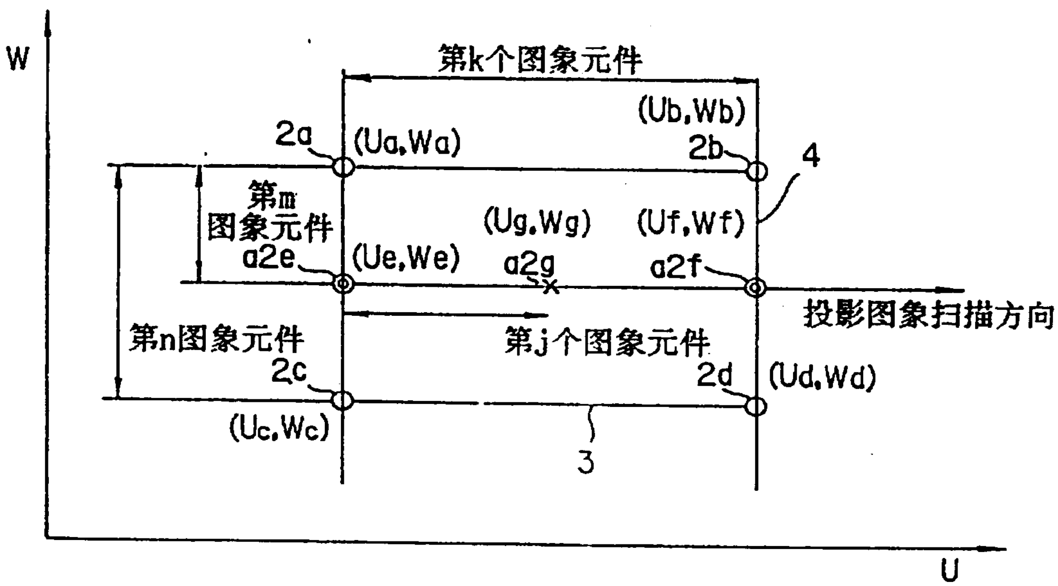


图 8



5 校正数据写入电路
存储地址发生电路
6
7
10
11
13
14
15
Sg
22
23
24
SEg
SEb
SEr
16
17
18
Sb
Sr
19
20
21
H
V
CK
(G)
(B)
(R)
(G)
(B)
(R)
8
9
12
SLg
SLb
SLr
25
26
27
31 校正调制区
校正数据存储部分 28
29
校正数据运算部分
30
D/A
变换区部分

图 9



W
第k个图象元件
(Ub,Wb)
2a
(Ua,Wa)
2b
4
第m
图象元件
(Ug,Wg)
(Uf,Wf)
a2e
(Ue,We)
a2g
a2f
投影图象扫描方向
第n图象元件
第j个图象元件
2c
2d
(Ud,Wd)
(Uc,Wc)
3
U

图 10

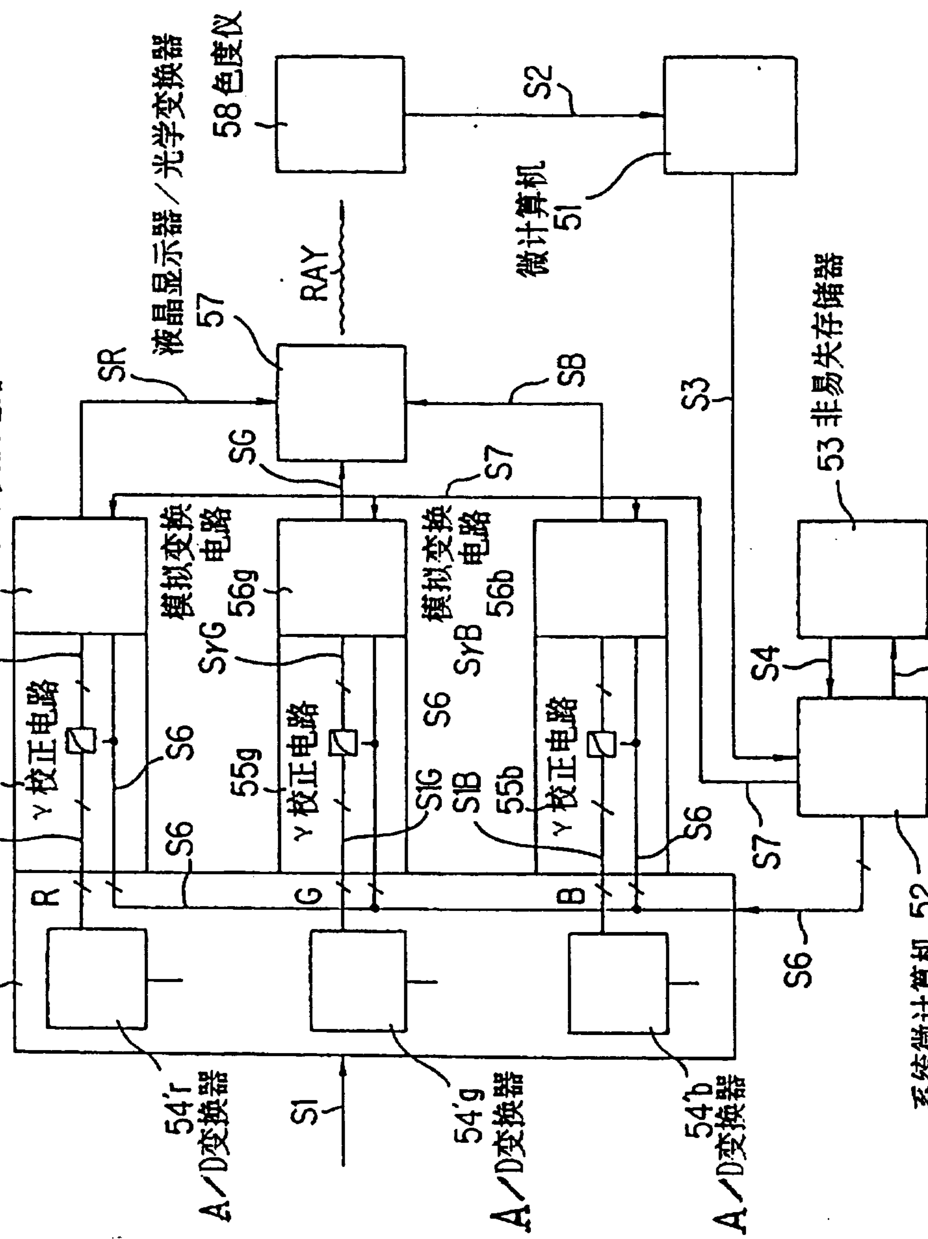
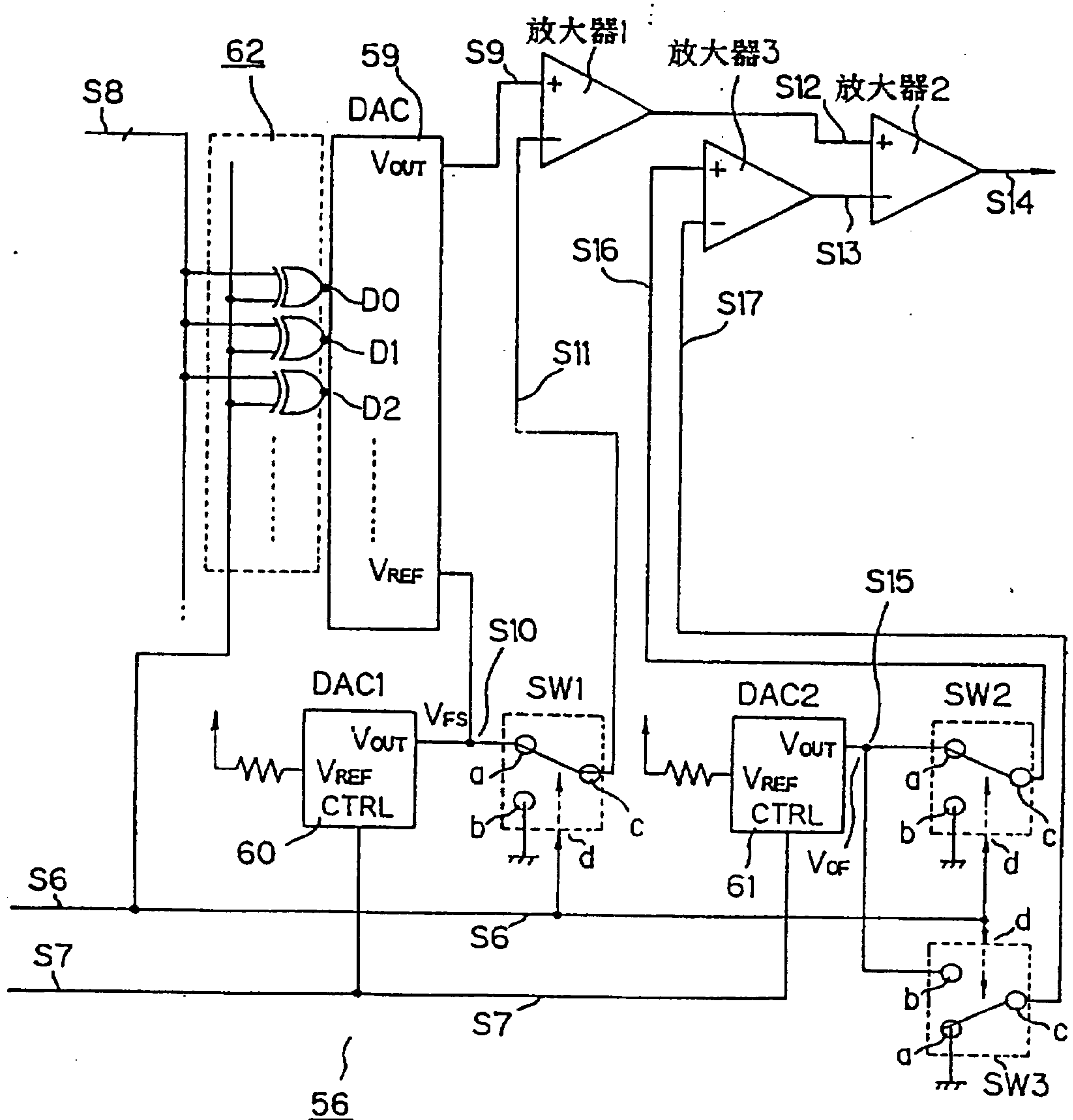

54
54'r A/D变换器
54'g A/D变换器
54'b A/D变换器
S1
R
G
B
S1R
S1G
S1B
55r γ校正电路
55g γ校正电路
55b γ校正电路
S6
SγR
SγG
SγB
56r 模拟变换电路
56g 模拟变换电路
56b 模拟变换电路
SR
SG
SB
S7
57 液晶显示器/光学变换器
RAY
58 色度仪
51 微计算机
S2
S3
53 非易失存储器
S4
S5
52 系统微计算机

图 11



放大器1
放大器3
放大器2
S8
62
59
DAC
S9
V_{OUT}
S12
S14
S13
S16
S17
D0
D1
D2
S11
V_{REF}
S10
S15
DAC1
SW1
DAC2
SW2
V_{FS}
V_{OUT}
V_{REF}
CTRL
a
b
c
d
60
61
V_{OF}
S6
S7
SW3
56

图 12 A

图 12 B

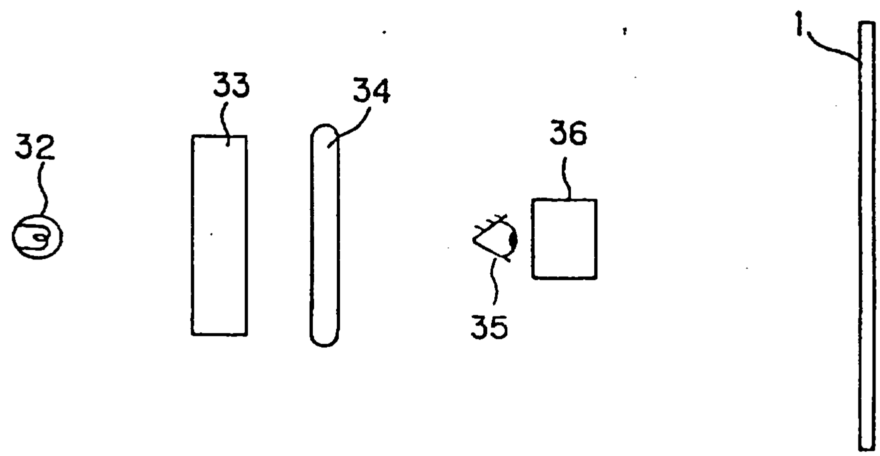


图 13A

图 13C

图 13F

图 13B

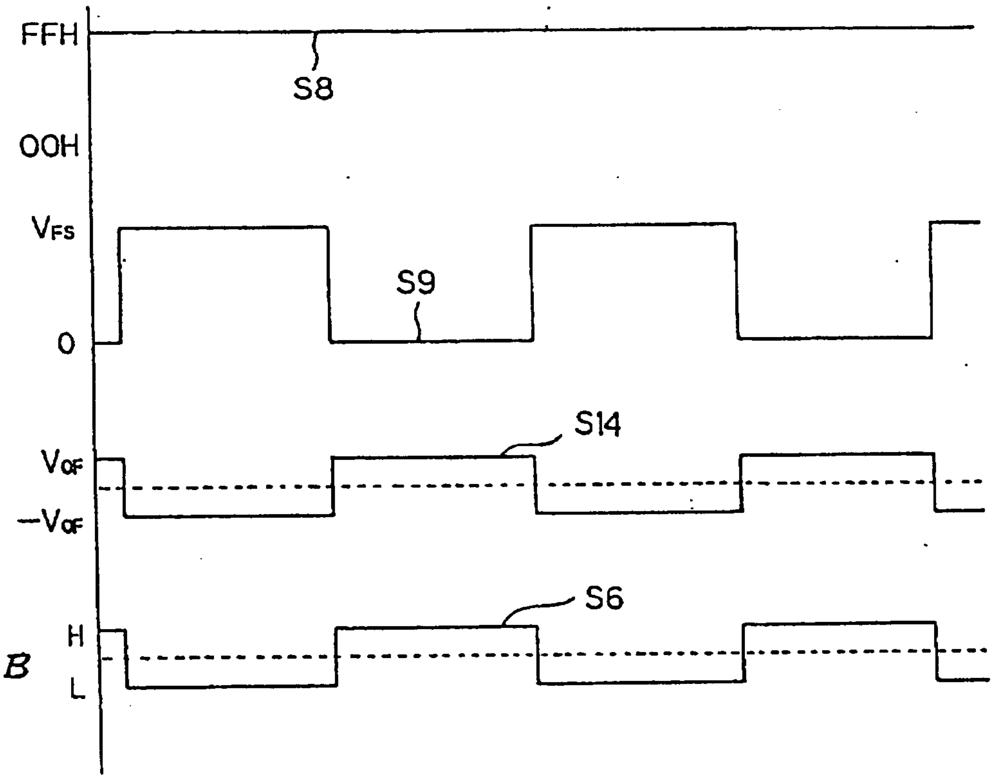
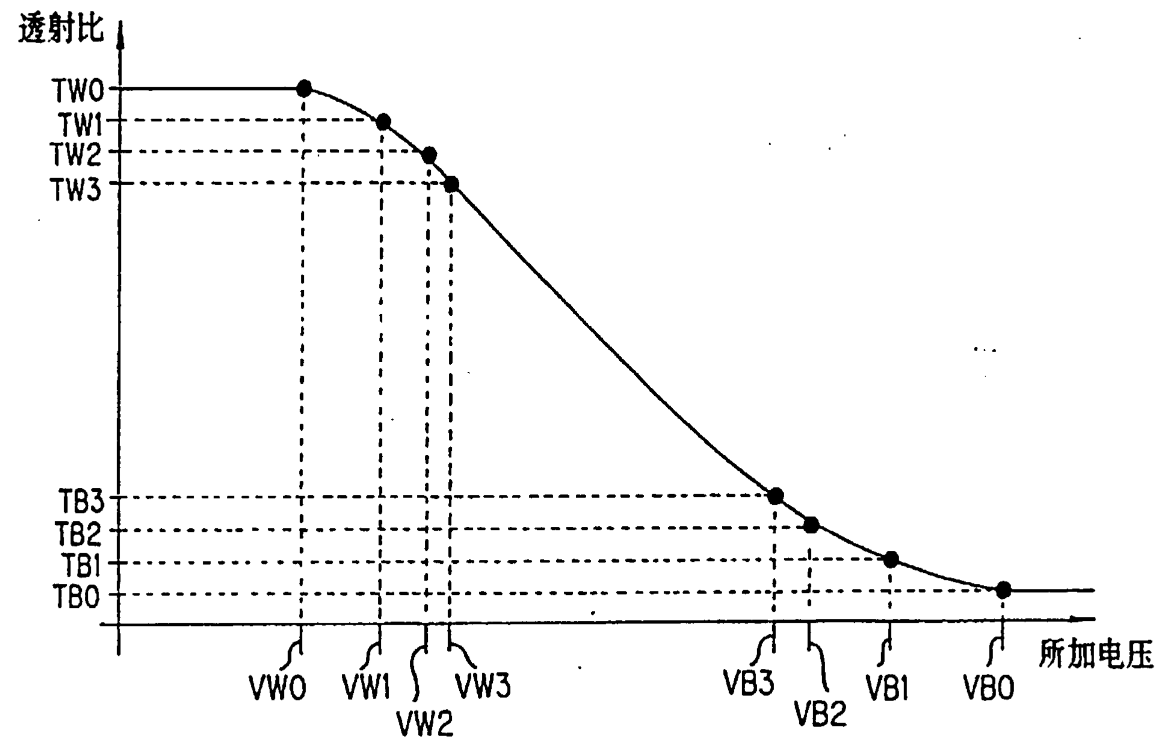


图 14



透射比
TW0
TW1
TW2
TW3
TB3
TB2
TB1
TB0
VW0
VW1
VW2
VW3
VB3
VB2
VB1
VB0
所加电压

图 15

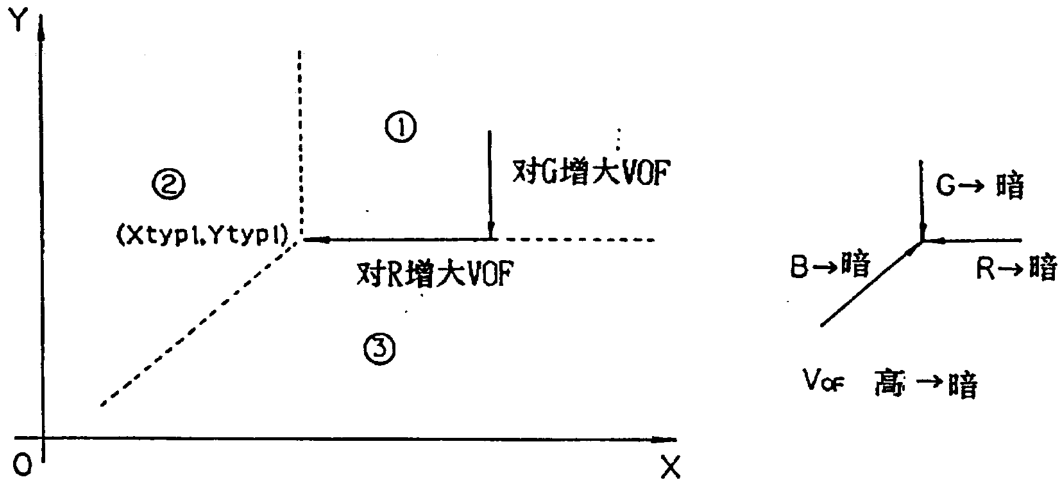


图 16A

区域	控制步骤	控制步骤
①	G	R
②	B	G
③	B	R

图 16B

区域	控制步骤	控制步骤
④	G	R
⑤	B	R
⑥	B	G

图 17A

图 17C

图 17F

图 17B

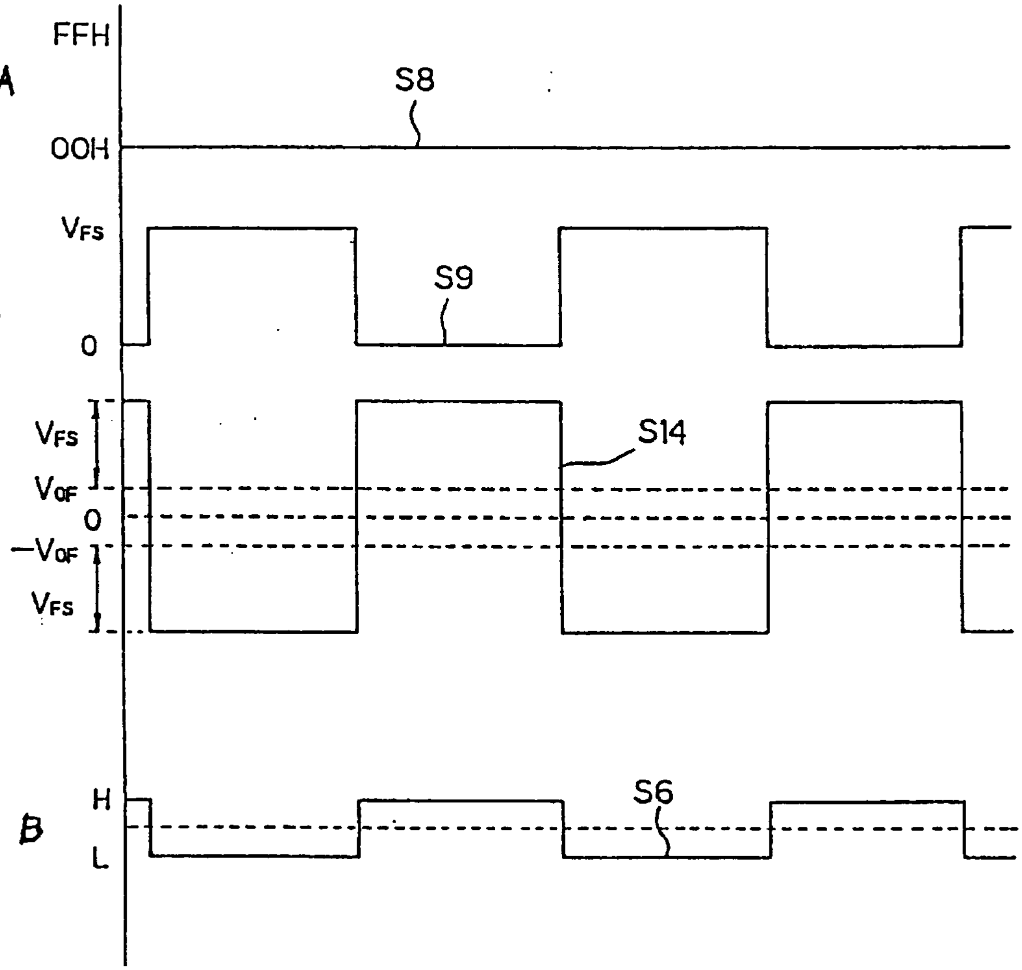


图 18